ALBERT R. MANN
LIBRARY

NEW YORK STATE COLLEGES
OF
AGRICULTURE AND HOME ECONOMICS

AT

CORNELL UNIVERSITY

Cornell University Library
SF 61.I61P
Principles of animal feeding, principles
3 1924 003 685 918
mann

The original of this book is in
the Cornell University Library.

There are no known copyright restrictions in
the United States on the use of the text.

http://www.archive.org/details/cu31924003685918

INTERNATIONAL LIBRARY OF TECHNOLOGY

A SERIES OF TEXTBOOKS FOR PERSONS ENGAGED IN THE ENGINEERING PROFESSIONS AND TRADES OR FOR THOSE WHO DESIRE INFORMATION CONCERNING THEM. FULLY ILLUSTRATED AND CONTAINING NUMEROUS PRACTICAL EXAMPLES AND THEIR SOLUTIONS

PRINCIPLES OF ANIMAL FEEDING
PRINCIPLES OF ANIMAL BREEDING
DAIRY BARNS AND EQUIPMENT
BREEDS OF DAIRY CATTLE
DAIRY-CATTLE MANAGEMENT
MILK
FARM BUTTER MAKING
BEEF AND DUAL-PURPOSE CATTLE

64679X

SCRANTON:
INTERNATIONAL TEXTBOOK COMPANY
122

SF
61
I 61P

322644

Principles of Animal Feeding: Copyright, 1912, by INTERNATIONAL TEXTBOOK COMPANY.

Principles of Animal Breeding: Copyright, 1911, by INTERNATIONAL TEXTBOOK COMPANY.

Dairy Barns and Equipment: Copyright, 1912, by INTERNATIONAL TEXTBOOK COMPANY.

Breeds of Dairy Cattle: Copyright, 1911, by INTERNATIONAL TEXTBOOK COMPANY.

Dairy-Cattle Management, Part 1: Copyright, 1911, by INTERNATIONAL TEXTBOOK COMPANY.

Dairy-Cattle Management, Part 2: Copyright, 1912, by INTERNATIONAL TEXTBOOK COMPANY.

Milk: Copyright, 1911, by INTERNATIONAL TEXTBOOK COMPANY.

Farm Butter Making: Copyright, 1911, by INTERNATIONAL TEXTBOOK COMPANY.

Beef and Dual-Purpose Cattle, Parts 1 and 2: Copyright, 1912, by INTERNATIONAL TEXTBOOK COMPANY.

Beef and Dual-Purpose Cattle, Parts 3 and 4: Copyright, 1913, by INTERNATIONAL TEXTBOOK COMPANY.

Copyright in Great Britain

All rights reserved

25882

PREFACE

The International Library of Technology is the outgrowth of a large and increasing demand that has arisen for the Reference Libraries of the International Correspondence Schools on the part of those who are not students of the Schools. As the volumes composing this Library are all printed from the same plates used in printing the Reference Libraries above mentioned, a few words are necessary regarding the scope and purpose of the instruction imparted to the students of—and the class of students taught by—these Schools, in order to afford a clear understanding of their salient and unique features.

The only requirement for admission to any of the courses offered by the International Correspondence Schools, is that the applicant shall be able to read the English language and to write it sufficiently well to make his written answers to the questions asked him intelligible. Each course is complete in itself, and no textbooks are required other than those prepared by the Schools for the particular course selected. The students themselves are from every class, trade, and profession and from every country; they are, almost without exception, busily engaged in some vocation, and can spare but little time for study, and that usually outside of their regular working hours. The information desired is such as can be immediately applied in practice, so that the student may be enabled to exchange his present vocation for a more congenial one, or to rise to a higher level in the one he now pursues. Furthermore, he wishes to obtain a good working knowledge of the subjects treated in the shortest time and in the most direct manner possible.

In meeting these requirements, we have produced a set of books that in many respects, and particularly in the general plan followed, are absolutely unique. In the majority of subjects treated the knowledge of mathematics required is limited to the simplest principles of arithmetic and mensuration, and in no case is any greater knowledge of mathematics needed than the simplest elementary principles of algebra, geometry, and trigonometry, with a thorough, practical acquaintance with the use of the logarithmic table. To effect this result, derivations of rules and formulas are omitted, but thorough and complete instructions are given regarding how, when, and under what circumstances any particular rule, formula, or process should be applied; and whenever possible one or more examples, such as would be likely to arise in actual practice—together with their solutions—are given to illustrate and explain its application.

In preparing these textbooks, it has been our constant endeavor to view the matter from the student's standpoint, and to try and anticipate everything that would cause him trouble. The utmost pains have been taken to avoid and correct any and all ambiguous expressions—both those due to faulty rhetoric and those due to insufficiency of statement or explanation. As the best way to make a statement, explanation, or description clear is to give a picture or a diagram in connection with it, illustrations have been used almost without limit. The illustrations have in all cases been adapted to the requirements of the text, and projections and sections or outline, partially shaded, or full-shaded perspectives have been used, according to which will best produce the desired results. Half-tones have been used rather sparingly, except in those cases where the general effect is desired rather than the actual details.

It is obvious that books prepared along the lines mentioned must not only be clear and concise beyond anything heretofore attempted, but they must also possess unequaled value for reference purposes. They not only give the maximum of information in a minimum space, but this information is so ingeniously arranged and correlated, and the

indexes are so full and complete, that it can at once be made available to the reader. The numerous examples and explanatory remarks, together with the absence of long demonstrations and abstruse mathematical calculations, are of great assistance in helping one to select the proper formula, method, or process and in teaching him how and when it should be used.

The material presented in this volume is intended to form a simple yet thorough treatment of the basic principles on which depend the successful feeding and breeding of farm animals. The various recognized breeds of dairy, beef, and dual-purpose cattle are described in detail and illustrations of typical animals are shown. Sanitation as it relates to the health of animals and also as it affects the quality and healthfulness of milk and butter is clearly and concisely discussed. Other important matters treated are, the establishment of dairy herds, care of dairy cattle, approved methods of handling and marketing dairy products, barns and their equipment, and the establishment and management of beef-cattle herds. Because of the concise and practical treatment of the problems that present themselves to dairymen and stockmen engaged in raising beef and dual-purpose cattle it is believed that the volume will be extremely helpful to those who are interested in this phase of agriculture.

The method of numbering the pages, cuts, articles, etc. is such that each subject or part, when the subject is divided into two or more parts, is complete in itself; hence, in order to make the index intelligible, it was necessary to give each subject or part a number. This number is placed at the top of each page, on the headline, opposite the page number; and to distinguish it from the page number it is preceded by the printer's section mark (§). Consequently, a reference such as § 16, page 26, will be readily found by looking along the inside edges of the headlines until § 16 is found, and then through § 16 until page 26 is found.

INTERNATIONAL TEXTBOOK COMPANY

CONTENTS

	Section	Page
PRINCIPLES OF ANIMAL FEEDING		
Introduction	25	1
Composition of Feeds	25	3
Functions of Feed	25	7
Functions of Feed Compounds	25	8
Digestion of Feed	25	11
Absorption of Feed	25	17
Factors Influencing Digestibility of Feed	25	18
Classification of Feeds	25	22
Concentrates	25	22
Roughage	25	24
Selection and Use of Feeds	25	29
Balanced Rations	25	29
Miscellaneous Factors Affecting the Selection and Use of Feeds	25	34
Feeding Tables	25	38
PRINCIPLES OF ANIMAL BREEDING		
Reproduction	26	2
Germ Cells	26	4
Reproductive Organs	26	6
Fertilization	26	9
Development of the Embryo	26	11
Birth	26	12
Abortion	26	15
Sterility	26	16
Laws of Breeding	26	17
Law of Heredity	26	17
Law of Variation	26	25
Breeding Operations	26	32

PRINCIPLES OF ANIMAL BREEDING—*Continued*	*Section*	*Page*
Selection of Animals for Breeding	26	32
Inbreeding	26	39
Breeding to Points and Improvement of Breeds	26	46
Castration	26	46
Determination of Sex	26	47
Breeding Records	26	49
Standard of Excellence	26	53
DAIRY BARNS AND EQUIPMENT		
Dairy Barns	41	1
Location of Dairy Barns	41	6
Construction of Dairy Barns	41	8
Ventilation of Dairy Barns	41	15
Equipment for Dairy Barns	41	19
Stanchions and Stalls	41	19
Mangers and Watering Troughs	41	28
Carrying Devices	41	30
Rectangular Dairy Barns	41	35
Round Dairy Barns	41	57
Polygonal Dairy Barns	41	63
Basement Dairy Barns	41	67
BREEDS OF DAIRY CATTLE		
Dairy Type of Cattle	42	1
Dairy Breeds	42	4
Jersey Cattle	42	4
Guernsey Cattle	42	8
Holstein-Friesian Cattle	42	13
Ayrshire Cattle	42	19
Dutch Belted Cattle	42	24
Brown Swiss Cattle	42	28
Simmenthal Cattle	42	29
French Canadian Cattle	42	29
Devon Cattle	42	30
Shorthorn Cattle	42	32
Red Polled Cattle	42	32

	Section	Page
DAIRY-CATTLE MANAGEMENT		
Selection of Dairy Cattle	43	1
Selection of Dairy Cows	43	1
Selection of the Dairy Bull	43	17
Systems of Dairying	43	19
Miscellaneous Information	43	24
Management of Dairy Cows	44	1
Management of Calves	44	16
Management of Dairy Bulls	44	19
Registration of Dairy Cattle	44	22
MILK		
Secretion of Milk	45	1
Composition of Milk	45	3
Contamination of Milk	45	10
Bacteria in Milk	45	10
Preserved Milk	45	32
Milk Fermentations	45	32
Pathogenic Bacteria in Milk	45	39
Absorption of Odors by Milk	45	44
Market Milk	46	1
Profits in Milk Production	46	1
Weighing, Testing, and Keeping Records of Milk	46	8
Milk Standards of the United States	46	17
Milk Standards of Canada	46	32
Handling of Market Milk	46	33
FARM BUTTER MAKING		
Quarters for Farm Butter Making	47	3
Cream-Separating Equipment	47	8
Centrifugal Separators	47	8
Devices for Gravity Separation	47	15
Churns	47	19
Miscellaneous Equipment	47	24
Butter-Making Operations	47	35
Centrifugal Separation of Cream	47	35
Gravity Separation of Cream	47	37

FARM BUTTER MAKING—*Continued*	*Section*	*Page*
Babcock Test for Cream, Skim Milk, and Buttermilk	47	40
Ripening of Cream	47	42
Determination of Acidity in Cream	47	47
Churning	47	49
Salting, Working, and Packing of Butter	47	55
BEEF AND DUAL-PURPOSE CATTLE		
Definitions and Explanations	48	1
Beef and Dual-Purpose Types of Cattle	48	5
Beef Breeds of Cattle	48	9
Shorthorn Cattle	48	9
Polled Durham Cattle	48	16
Hereford Cattle	48	20
Aberdeen-Angus Cattle	48	28
Galloway Cattle	48	35
Sussex Cattle	48	40
Dual-Purpose Breeds of Cattle	48	43
Devon Cattle	48	43
Red Polled Cattle	48	46
Brown Swiss Cattle	48	50
Shorthorn Cattle	48	52
Market Classes of Cattle	49	1
Beef Class of Cattle	49	4
Butcher Stock	49	12
Cutters and Canners	49	22
Stockers and Feeders	49	27
Veal Calves	49	42
Milkers and Springers	49	46
Baby-Beef Cattle, Distillers, and Texas and Western Ranch Cattle	49	47
Export, Shipping, and Dressed-Beef Cattle	49	51
The Beef Carcass	49	54
Judging of Beef Cattle	49	60
Judging of Dual-Purpose Cattle	49	69
Equipment for Beef and Dual-Purpose Cattle	50	1
Barns	50	1
Sheds	50	15

BEEF AND DUAL-PURPOSE CATTLE—*Continued*	*Section*	*Page*
Feed Bunks and Miscellaneous Equipment	50	25
Feeds for Beef and Dual-Purpose Cattle	50	40
Founding of a Herd	51	1
Selecting of Foundation Stock	51	2
Management of Beef and Dual-Purpose Cattle	51	8
Management of a Breeding Herd	51	8
Management of Cattle for Market	51	32
Fitting of Cattle for Exhibition	51	43
Castration of Calves	51	48
Dehorning of Cattle	51	49
Branding of Cattle	51	51
Registering of Cattle	51	51

PRINCIPLES OF ANIMAL FEEDING

INTRODUCTION

1. The successful feeding of farm animals is based upon certain fundamental principles. These principles have to do with the chemical composition of feedstuffs, their mastication, digestion, absorption, and assimilation in the animal body; with the feed requirements of different classes of farm animals for maintenance, growth, fattening, work, and milk production; and with the source and availability of feeds, their palatability, cost, and physical properties. The principles of feeding discussed in the following pages are equally applicable for all classes of livestock.

The sum of knowledge from which have been evolved the principles of feeding has been made up and contributed to by the observation of the results and methods of practical stock raisers and feeders, by practical feeding tests or experiments performed scientifically by the experiment stations, and by the discoveries of scientific investigators in chemistry and physiology. From these three sources of knowledge have been supplied such a large accumulation of facts that the principles are well supported. It is not possible to say that the experience of the practical feeder is more necessary to the beginner than a knowledge of the chemistry of feeds and the physiology of the animal body. Both are indispensable for the best success, and each supplements the other. To understand the principles of feeding, a person must know what scientists teach, and to be able to put them into successful practice he must have

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

experience. To be successful the practical man must be a student, get down below the surface of things, and seek the reasons for good or bad results in the feeding yard. The scientist, or the person with only a book knowledge of feeding, must get experience and appreciate the necessity of close observation of the habits, characteristics, and peculiarities of animal life on the farm before he can be expected to feed successfully or to instruct others in the art. Successful feeding is, therefore, both an art and a science; it involves not only the method, or how to do, but also the reasons for those methods.

The principles of animal feeding should be used as guides rather than as absolute rules in practice. They are valuable aids to experience, but they cannot take its place. The principle is general in its application, while the practice must be specific. Conditions of environment vary so widely in different sections of the country, and from season to season; the individuality of the animals fed is so marked; and the price and availability of feeds are so changing that the practices of a feeder and his methods must be determined largely by his individual conditions and circumstances. A method that is successful with one class of animals may not give good results with another class, and what is considered to be a successful practice in one part of the country might give very unsatisfactory results in another. The value of a knowledge of the principles of feeding should, therefore, be apparent, for their application is universal. With a knowledge of the principles of feeding, the feeder himself is in a position where he is better able to solve his own problems than any one from without who is unacquainted with his particular conditions. He is also equipped to interpret intelligently and to use the results of experimental work.

COMPOSITION AND FUNCTIONS OF FEEDS

COMPOSITION OF FEEDS

2. It is a matter of common observation on farms that certain feeds tend to produce growth—the formation of bone, muscle, etc.; that other feeds tend to produce fat; and that still other feeds tend to produce milk. The reason that different feeds produce different results is largely that of the difference in their composition; therefore, a knowledge of the composition of a feed is a valuable guide to the man that feeds livestock.

In discussing the composition of feeds it is necessary to make use of the chemical terms *element* and *compound*. An **element** is a form of matter that cannot be separated by any method known to science into two or more simpler substances. Carbon, hydrogen, oxygen, nitrogen, phosphorus, and iron are elements. The total number of elements that have been discovered by scientists is about eighty, which, so far as known, compose the whole matter of the universe. A **compound** is a chemical combination of two or more elements. For example, water is a compound of the two elements hydrogen and oxygen. Starches and sugars are compounds of carbon, hydrogen, and oxygen in definite proportions. Of the entire number of elements, only about fifteen enter into the compounds of plant and animal matter, and many of these fifteen elements are found only in very small quantities. These fifteen elements are carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, sodium, potassium, calcium, magnesium, iron, manganese, silicon, fluorine, and chlorine.

These elements do not occur in a free form in feeds but make compounds, which in turn form the feeds. Chemists in analyzing feeds have made five classes or groups into which all compounds that are found in feeds are placed. These classes are

water, ash, protein, carbohydrates, and fat. The following tabulation shows the elements that make up the compounds of each class, and Table II, which appears at the end of this Section, shows the per cent. of each class of compounds in the common American feedstuffs.

Water	Hydrogen, Oxygen	Protein	Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur, Phosphorus, Iron
Ash	Oxygen, Sodium, Potassium, Calcium, Magnesium, Iron, Manganese, Sulphur, Phosporus, Silicon, Fluorine, Chlorine	Carbohydrates	Carbon, Hydrogen, Oxygen
		Fat	Carbon, Hydrogen, Oxygen

3. Water in Feeds.—All feedstuffs contain water, although the more water that a feed contains the smaller is its nutritive value. In young and growing plants the presence of water is readily apparent; it represents from 70 to 90 per cent. of the total weight of such plants. Air-dried feeds, such as the grains, corn, wheat, and oats, and well-cured hays, contain on an average only from 8 to 15 per cent. of moisture, or water; but some of the succulent feeds contain a very large percentage of water. Thus, green Kentucky blue grass contains 65.1 per cent. of water; green clover, 70.8 per cent.; corn silage, 73.6 per cent.; potatoes, 79.1 per cent.; sugar beets, 86.5 per cent.; and mangel wurzels, 90.9 per cent.

4. Ash in Feeds.—The mineral matter, or **ash,** of a feed is the portion that is left after complete burning; it is, therefore the incombustible part.

The common farm feeds contain but a small percentage of ash, although the percentage varies greatly in different feeds.

Thus, potatoes contain .9 per cent. of ash; rutabagas, 1.2 per cent.; corn, 1.5 per cent.; oats, 3.2 per cent.; timothy hay, 4.4 per cent.; Red clover hay, cut when the clover is in bloom, 6.6 per cent.; and alfalfa hay, 8.6 to 10.6 per cent. It may be noticed that legumes are high in their content of ash.

Although the mineral constituents usually represent a very small proportion of the dry matter of a feed, they are an important and essential part of every ration. At one time it was thought that almost all rations for domestic animals supplied sufficient mineral matter to meet the demands of the animals fed, but the conclusions recently reached by scientists indicate that the supply of these constituents is frequently lacking. The poor results from feeding only corn to young pigs are due largely to a deficiency of mineral matter in the ration.

5. Protein in Feeds.—All plant and animal compounds that contain the element nitrogen are grouped into a class to which the term **protein** is applied. This is a very general term and the number of compounds included in this group is exceedingly large. In addition to nitrogen, there are always found in protein the elements carbon, hydrogen, and oxygen, and sometimes sulphur, phosphorus, and iron. Owing to the fact that nitrogen is found in all the compounds included in this class, they are often spoken of as nitrogenous compounds.

The percentage of protein in the different parts of plants varies exceedingly. Usually the seeds of plants contain a larger percentage of nitrogenous compounds than do the whole plants; and certain parts of the seeds are richer in these compounds than other parts. Thus, dry corn fodder (ears on) contains only 4.5 per cent. of protein; shelled corn, about 10.3 per cent.; and gluten feed, a by-product in the manufacture of corn starch from shelled corn, 25 per cent. Wheat straw contains 3.4 per cent. of protein; wheat grain, 11.9 per cent.; and bran, shorts and middlings, by-products in the manufacture of flour, contain from 12 to 17 per cent. Some of the by-products of slaughter houses are used as feeds and are usually very rich in protein. A few of the more highly nitrogenous feeds, which are sometimes referred to as protein feeds, and their per cent. of

protein are: blood meal, or dried blood, 84.4 per cent.; tankage, 53.9 per cent.; cottonseed meal, 45.3 per cent.; old-process linseed meal, 33.9 per cent.; soybeans, 33.5 per cent.; gluten feed, 25 per cent.; cowpeas, 20.5 per cent.; wheat middlings, 16.9 per cent.; and wheat bran, 15.7 per cent.

Most of the feeds ordinarily grown on the farm do not contain sufficient protein to satisfy the demands of the animals fed. Commercial protein feeds like those just mentioned are, therefore, widely used in connection with corn, timothy hay, corn stover, corn fodder, etc. The commercial feeds, which are sometimes called supplemental feeds, owe their value and extensive use almost entirely to their content of protein. A fact in connection with the use of protein feeds is that when they are fed to farm animals the manure voided by these animals is rich in nitrogen, and is, therefore, of particular value in maintaining soil fertility. The fact that livestock must be depended upon generally as a very successful and economical means of maintaining and building up the productive capacity of soils makes this phase of the feeding problem increasingly important.

6. Carbohydrates in Feeds.—Like protein, the term carbohydrate is a general one and is the name of a large group of compounds. All **carbohydrates** are alike, however, in that they contain only the three elements, carbon, hydrogen, and oxygen. The hydrogen and oxygen are present in the same ratio as they are in water, that is, 2 parts hydrogen to 1 part of oxygen.

There are two general classes of carbohydrates, namely, crude fiber and nitrogen-free extract. Crude fiber constitutes the framework, or skeleton, of plants, such as the hard, woody portions of corn stalks and of straws. The husks of grains, such as oat hulls and corn and wheat bran, contain large quantities of this material; wood also is an example of crude fiber. Carbohydrates of the nitrogen-free-extract class are much more valuable as sources of feed than are those of the crude-fiber class, because the former are more easily digested than the latter. Familiar examples of the nitrogen-free-extract compounds are

corn starch and common sugar. There are many kinds of sugars and starches, but the feed values of all are very similar. Most of the more common feeds raised on farms contain a large percentage of carbohydrates. So large, in fact, is this proportion that most rations that are made from these feeds contain too large a proportion of carbohydrates. Corn contains 72.6 per cent. of carbohydrates; wheat, 73.7 per cent.; oats, 70.2 per cent.; rye, 76 per cent.; barley, 72.9 per cent.; corn fodder, 49 per cent.; corn stover (without ears), 51.2 per cent.; and timothy hay, 74 per cent.

7. Fat in Feeds.—The term **fat,** as it is used in connection with feeds, applies to all true fats and oils, as well as to all other feed compounds that are soluble in ether, and because of this fact the terms ether extract and fat are used synonymously in tables showing the composition of feedstuffs. The ether extract, or fat, in seeds and other concentrates consists largely of true fats and oils; but the ether extract, or fat, of coarse fodders and straw consists largely of waxes and chlorophyl, which are compounds that have less feed value than the true fats and oils. Although all feeds contain some fat, the percentage of these compounds in feeds varies widely. Rye contains 1.9 per cent. of fat; wheat, 2.1 per cent.; corn, 5 per cent.; oats, 4.8 per cent.; soybeans, 17.2 per cent.; cottonseed, 19.9 per cent.; sunflower seed, 21.2 per cent.; flaxseed, 33.7 per cent.; and peanuts (with hulls), 35 per cent.

FUNCTIONS OF FEED

8. Production of Energy.—The first function of feed is to furnish energy. All the physiological activities as well as the general and necessary movements of the animal body require energy for their support. The mastication of the feed, the beating of the heart, the circulation of the blood, and the movement of the feed along the alimentary tract all necessitate a constant supply of energy. In addition, cell changes, or vital activity in every organ and every gland of the body, represent the expenditure of energy. In a sense, the living

animal is an engine at work. The feed represents the fuel; the activities mentioned, the necessary work. Even in a state of apparent rest the body is burning fuel and using energy. But when any kind of exercise is taken, a large amount of energy is used. If more feed is consumed than is necessary to supply the immediate requirements for energy, an excess of energy is stored up in the form of fat, and this may be drawn upon at times when there is too small a quantity of feed consumed to create the necessary energy.

9. Production of Tissues and Secretion of Fluids.—Another function of feed is to build up the various tissues and to secrete the fluids of the body. The growth of young animals, the production of fat, and the secretion of milk are examples of this function. All parts of the animal body are tissues and are continuously being worn out and replaced. And the replacing, also the wearing out, of all tissues whether it be muscle, fat, bone, skin, hair, horn, hoof, wool, blood, nerve, cartilage, tendons, vital organs, or what not requires an expenditure of energy, which in turn requires the consumption of feed.

The muscles, the vital organs, the blood, the skin, hair, wool, the horn and hoofs, and the cartilages and tendons are produced from feeds rich in protein, and for this reason they are sometimes called protein tissues.

FUNCTIONS OF FEED COMPOUNDS

10. Functions of Water in Feed.—Water, although not a source of energy, is a necessary constituent of every tissue and its presence is fundamental to the activities of all living matter. The active, living cell is more than 90 per cent. water; the animal body as a whole is more than 50 per cent. water; the digestive juices, the blood and lymph, and all the other fluids and secretions of the body, in most cases, contain from 85 to 99 per cent. of this important constituent of feed. Water is the vehicle, or means, that enables the digested feed to be absorbed, transported to the tissues, and the residue, or waste

material, to be conveyed from the tissues to the organs of elimination. It also performs the important function of aiding in maintaining the normal temperature of the body. The supply of water is not limited to the feed eaten, and does not demand the same attention from feeders as many of the other feed constituents, a necessary supply of which is often lacking in many of the common farm feeds.

11. Functions of Ash in Feed.—One function of the ash, or mineral portion, of feed is to furnish material for the production of bone. The facts that strong bone in an animal is impossible without a plentiful supply of ash in its feed and that many feeds and rations do not contain a sufficient quantity of bone-making ingredients to meet the demands of growing animals make the supply of ash important to the feeder.

Also, ash forms an essential part of the blood, the digestive juices, and, in fact, all the secretions of the animal body. Common salt, one of the ash compounds, is particularly abundant in the animal body. Without the mineral constituents in feed animal life would be impossible, for all the important vital processes, such as digestion, assimilation, circulation, and respiration, depend in part on the presence of ash for support.

Another function of ash is to neutralize poisons. In the processes of nutrition, which involve the changing of the feed into living tissue, the burning of the feed to yield energy, and the breaking down or wearing out of old tissue, compounds are produced that are poisonous to the animal system. Certain of the ash ingredients then unite with these poisonous products and destroy their injurious properties.

12. Functions of Protein in Feed.—The most important function of the feed constituent, protein, is to build protein tissue. Due to the fact that protein is the only class of compounds that can be used by the body in forming muscular tissue, its supply must be constant and sufficiently abundant if good results are to be obtained. Special attention should be given to the supply of protein in rations for cows giving milk and for growing animals, because of the large quantity of protein required by these animals. The importance of this class

of compounds is emphasized, too, by the fact that the average ration, especially when corn is the chief grain crop, is often deficient in protein.

Another function of protein is to furnish energy. This function protein shares with the carbohydrates and fats. If the supply of protein is more than sufficient to satisfy the requirements for growth or for milk production, it is burned and the energy is used in the work of the animal and in the supplying of heat. As feeds that are rich in protein are usually high priced, no more protein should be fed than is necessary to build new or to replace worn-out protein tissue. The energy and heat demands of the animal can be more economically met by the feeding of carbohydrates and fats.

A possible function of protein is to build fat. However, authorities agree that under normal conditions fat production is never supported by this class of feed compounds. Experiments prove, on the other hand, that under some conditions the protein of the feed is capable of being used by the body in making fat.

13. Functions of Carbohydrates in Feed.—The carbohydrates are the great energy and heat producers of the animal body. Their abundance in the common hays and grains guarantees a plentiful supply in the rations ordinarily fed on farms to meet the demands of the animals fed.

The second function of these compounds is to build fat. It is a matter of common observation that feeds like corn have a strong tendency to produce fat in the animal body. In fact, the heating and fattening qualities of corn are so pronounced as to make it unbalanced, and when it is fed exclusively to pigs, for example, it promotes the development of fat at the expense of bone and muscle.

14. Functions of Fat in Feed.—The functions of fat are identical with those of the carbohydrates, that is, to produce energy and heat and to supply fat to the animal body. But for the production of energy and heat, fat has about two and one-fourth times the value of carbohydrates. That is, if the same quantity of both, carbohydrates and fat, are burned sepa-

rately and the heat given off in each case is measured, it will be found that the fat liberates approximately two and one-fourth times the amount of heat that the carbohydrates do. In the same way digested fat is more efficient in producing body heat than are digested carbohydrates.

DIGESTION AND ABSORPTION OF FEED

DIGESTION OF FEED

15. The process of **digestion** includes all the physical and chemical changes in feed that take place within the alimentary canal, which result in the feed being dissolved, or rendered capable of passing through the walls of the stomach or intestines into the circulatory system. In other words, it is the processes whereby the feed is made soluble and capable of being absorbed.

16. Digestive Changes in the Mouth.—The first and an important step in the process of digestion is mastication. By this action the feed is reduced to a more or less finely ground condition. At the same time, the feed is softened by the addition of fluids that are poured upon it from the glands in the mouth and thus rendered capable of being more easily swallowed.

In addition to the mechanical change in the feed, there are chemical changes that take place in the mouth. The digestive fluid, secreted by the salivary glands and known as *saliva*, contains a digestive ferment, or enzyme, called *ptyalin*, which acts on certain of the carbohydrate compounds, particularly starch, and tends to convert it into sugar. But, because of the fact that the feed is retained in the mouth a relatively short time, the action of the saliva in changing starch to sugar is limited.

17. Digestive Changes in the Stomach.—When mastication is complete, the feed passes down the esophagus into the stomach, where it is acted on by certain digestive juices. Before

considering the digestive processes occurring in the stomach, attention should be given to the anatomy of this important organ. The stomach of an ox is divided into four compartments. In Fig. 1, the *rumen*, known also as the first stomach, or paunch, is illustrated at *a* and *b*, *a* being the left hemisphere and *b* the right hemisphere; the termination of the esophagus is shown at *c*; the *reticulum*, second stomach, or honeycomb, at *d*; the *omasum*, third stomach, or manyplies, at *e*; the *abomasum*, fourth stomach, or rennet, at *f*; and the beginning of the small intestine at *g*. The stomach of the sheep and the

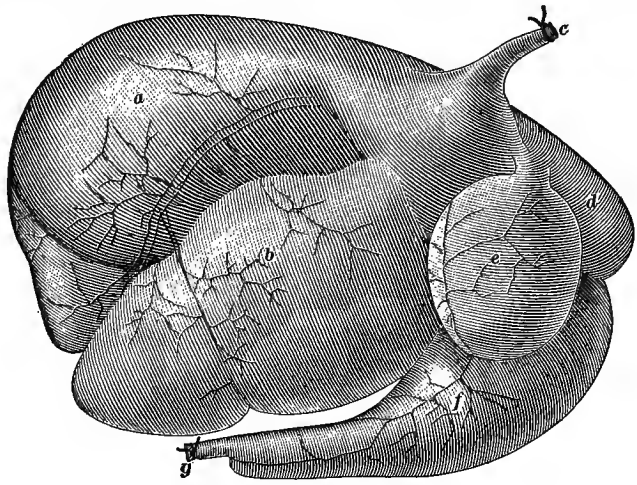


FIG. 1

goat is similar to that of the ox and has four more or less distinct compartments. The stomach of an ox holds from 40 to 60 gallons, and the rumen, or paunch, holds about nine-tenths of this quantity, or from 36 to 54 gallons.

The chief use, or function, of the rumen is that of a reservoir for the storing of large quantities of water and partly masticated feed. The large size of this compartment explains the wonderful capacity of cattle for coarse, rough feeds like fodder, straw, and hay. After remaining in the paunch long enough to be softened and somewhat mixed by the rolling action given to the contents by the muscular walls, the feed is passed back

to the mouth by a reverse process of swallowing called *regurgitation*. The feed is then remasticated and again swallowed, after which it passes directly to the third stomach. When ruminants, that is, animals that remasticate their feed, live mostly on rough, coarse feed, the amount of energy expended by them in chewing their feed is considerable, and, as the feed itself is the source of the energy, such animals fail to profit as much from coarse feed as from feed that is easily digested.

The reticulum, or second compartment, is the smallest of the four. Its chief function appears to be that of catching and holding foreign objects, such as small stones, nails, pieces of wire, etc. that may be swallowed with the feed, and, probably, of supplying water to the paunch when that compartment is forming its contents into cuds, or boluses, to be regurgitated.

The omasum, or third stomach, is a little larger than the reticulum, to which it connects. The contents of the third compartment of the stomach are usually rather dry. This is due to the grinding, pressing treatment given to the feed by the contraction of the strong muscular walls. In addition to the contraction of the walls, there extend from them leaf-like projections that aid in reducing the material to a finely ground condition. The function of the third stomach is, therefore, the mechanical preparation of the feed for the abomasum, or true stomach. In fact, nearly all of the changes to which the feed is subjected by the action of the first three compartments of the stomach is simply for the purpose of getting it ready for the true stomach, or abomasum, where digestion proper begins.

On reaching the true stomach the feed is subjected to the action of the *gastric juice*, a digestive fluid that is secreted in large quantities by the walls of this compartment. This fluid contains three essential ingredients—*hydrochloric acid*, *pepsin*, and *rennin*. The pepsin and rennin are the real digestive agents, but their action is limited or impossible when hydrochloric acid is absent. Like the ptyalin of the saliva, pepsin and rennin are ferments, or enzymes.

The protein compounds of the feed are the only ones affected by the pepsin and rennin. The action of the pepsin is to change certain of the nitrogenous bodies into *peptones*, which are sol-

uble forms of protein. The rennin causes the protein of milk to coagulate and in young animals that are fed chiefly on milk this ferment is very active. The action of rennin in milk is necessary, because not until the protein of milk is coagulated is the pepsin capable of changing it into peptones, that is, the final stage of the digestion of the protein of milk.

The stomach of the horse and of the pig consists of but one compartment. The stomach of a horse has a total capacity of from 2 to 4 gallons and that of a pig from $1\frac{1}{2}$ to 3 gallons. The stomach of a horse is illustrated in Fig. 2, in which the stomach end of the esophagus is shown at *a* and the beginning of the small intestines at *b*. Digestion in the stomach of a horse or a pig occurs in much the same manner as in the true stomach of an ox; the protein compounds of the feed are rendered soluble by the digestive ferments and are then in a form that they can be absorbed.

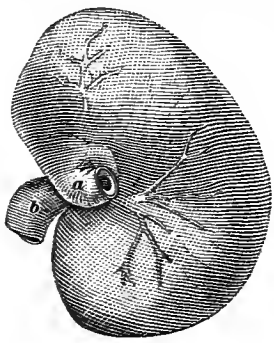


FIG. 2

18. Digestive Changes in the Intestines.—Most of the work of digestion is accomplished in the small and large intestines. Although the small intestines, which connect with the stomach, are of small diameter, certain portions of the large intestines expand into large compartments. In the horse, especially, a portion of the large intestines, known as the cæcum, has an enormous development; it is from 3 to 4 feet in length, and has a capacity of from 7 to 8 gallons. The function of the cæcum is similar to that of the paunch in the stomach of an ox, that is, that of a reservoir for the storage of water and coarse feed. At *a* in Fig. 3 is shown the cæcum of a horse; from a study of this illustration, which shows a ventral view of a horse with the abdominal floor removed to show the abdominal viscera, an idea of the relative size of the cæcum can be gained.

The feed, on passing from the stomach into the small intestine, comes in contact with two digestive fluids, the *bile* and

the *pancreatic juice*. The bile is secreted by the liver and, although the bile possesses no ferments, it performs a necessary part in the process of digestion. The first and probably the most important function of the bile is to change the acid condition of the feed as it comes from the stomach to an alkaline condition. This change is necessary because the contents

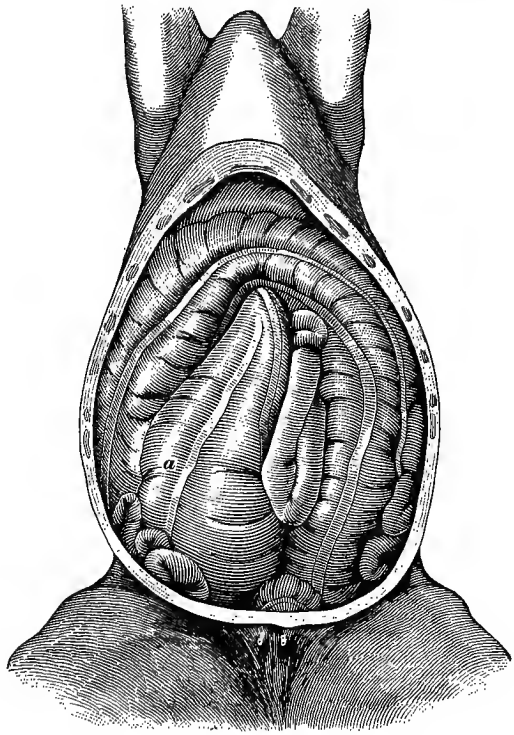


FIG. 3

of the intestine must be alkaline before the pancreatic juice can work to the best advantage. The bile aids also in the digestion of the fat of feed and is credited with antiseptic properties that tend to lessen the production of gas, which, if produced, is likely to hinder digestion.

The pancreatic juice possesses ferments that act upon all three classes of feed—the carbohydrates, protein, and fat.

When the material from the stomach has been changed to an alkaline condition by the bile, the ferments of the pancreatic juice act upon all the feed that has not been made soluble. The proteins are changed to peptones, the carbohydrates are converted into sugar, which is soluble, and the fats are split up, changed, and emulsified, in which finely divided condition they are capable of being passed through the walls of the intestines.

The fifth and last digestive fluid with which the feed comes in contact in its passage along the alimentary canal is the *intestinal juice*, which is secreted by the walls of the intestines and is responsible for the final work of digestion. Its action is concerned mainly with the undigested protein and carbohydrate compounds, but some physiologists claim that it possesses also the power of further digesting the fat. Although authorities disagree as to the importance and the extent of the activity of the intestinal juice in digestion, it is believed by many that its action, in a way, supplements or completes the action of all the other juices, especially those concerned with the digestion of carbohydrates.

19. Water in Digestion.—The water that forms a part of feed or that may be drunk by an animal is not changed chemically or physically in the process of digestion, but it is the medium in which the peptones, sugars, and emulsified fat compounds are carried into solution or suspension through the walls of the stomach and intestines.

20. Ash in Digestion.—The ash compounds of feed do not seem to be acted upon by the ferments of the digestive juices as are the protein, carbohydrate, and fat compounds. The various changes through which the ash compounds pass prior to their absorption and the agents responsible for these changes are not well understood.

21. Expulsion of the Undigested Part of Feed.—The portion of feed that is undigested, together with the residues of the digestive juices, are expelled from time to time by the animal as feces. The length of time required from the time a feed is eaten until the undigested residue is expelled varies

considerably with the different species of animal and with the nature of the feed eaten. According to some careful investigators it takes on an average from 3 to 4 days with cattle and sheep, about 36 hours with pigs, and probably from 2 to 3 days with horses.

ABSORPTION OF FEED

22. Absorption is the passing of the digested feed nutrients through the walls of the intestines and stomach into the circulation. As soon as the digestion of any particles of feed is complete, absorption begins. As parts of the feed, such as sugars and certain mineral compounds, are already soluble, their absorption begins almost immediately upon their entering the stomach. Since some of the protein, carbohydrate, and fat compounds are more soluble than others, the process of digestion and absorption occurs simultaneously, both continuing while the feed passes almost the entire length of the alimentary canal.

Absorption is accomplished chiefly in the intestines, where there is a fine network of blood and lymph vessels separated from the contents of the intestines by a very thin membrane. The liquid containing the solid feed compounds in the intestines being a denser fluid than that contained in the absorbing vessels, the feed passes through the intervening wall, or membrane, by the process of osmosis. This process is explained by the fact that when two liquids of unequal density are separated by an animal membrane a portion of the denser solution passes through the membrane into the lighter solution.

Both the lymphatic and blood circulatory systems play an important part in the absorption of the digested feed and its transportation to the various tissues of the animal body. This is one of the important functions of the circulatory system, for before any of the feed nutrients can be used in furnishing energy to the body, in building fat, bone, or muscle, or in the formation of milk, they must be conveyed to the living tissue cells. The digested protein, the sugar from the digested starch, and the soluble mineral compounds reach the general circulation, mainly, by way of the blood in the venous capillaries

located in the lining of the alimentary canal. These capillaries, or minute blood vessels, converge into the portal vein, which conveys the absorbed feed compounds to the liver. From the liver they are transported by the hepatic vein to the general circulation. The capillaries of the lymphatic system lie alongside the capillaries of the blood vessels in the intestinal wall, but absorb only the digested fat and probably a part of the peptones. These capillaries converge to form larger vessels that unite with the main trunk of the lymphatic system, the thoracic duct, from which its milky-like contents are poured into the blood circulation. After reaching the circulation of the blood, the feed compounds are soon brought in contact with every living tissue cell of the animal body. Here is where the real processes of nutrition take place, and the feed yields up its energy by being oxidized or is deposited in the form of protein, bone, or fat tissue, according to the demands of the cell and the nature of the feed brought to it.

FACTORS INFLUENCING DIGESTIBILITY OF FEED

23. The digestibility of a feed or a ration is determined by subtracting the dry matter of the feces from the dry matter of the feed eaten. The difference represents the portion digested and absorbed into the circulation. Digestion experiments have been extensively conducted with the several classes of farm animals and from these tests the experimenters have been able to determine not only the percentage of total dry matter digested but also the digestibility of each one of the several classes of feed compounds in the separate feedstuffs. Table III shows the total dry matter and the digestible nutrients in 100 pounds of most of the feeds commonly used in America.

The value of a feed or ration depends on its composition and the completeness with which it is digested. The factors that influence digestibility are therefore important considerations for the feeder's attention. Among these factors are the *character of the feed;* the *species of animal* to which the feed is fed; the

palatability of the feed; the *preparation of the feed;* the *quantity of the ration;* and the *frequency of feeding.*

24. Character of the Feed.—The chemical composition of a feed greatly influences its digestibility. Some feeds have as high as 90 per cent. digestibility; other feeds have as low as 40 per cent. and a few, perhaps, less. This difference is due almost entirely to the quantity of crude fiber that the feed contains. Corn stalks, wheat straw, and such feeds contain large quantities of crude fiber and are very imperfectly digested even by ruminants. Concentrated feeds like corn, oil meal, etc., are much more completely digested because their content of crude fiber is very low. The digestibility of a feed can be very closely predicted by a knowledge of its composition. In fact, the digestibility of a feed varies indirectly with the quantity of crude fiber present. It is a well-known fact that the proportion of crude fiber in plants, especially grasses, increases with their maturity, and because of this fact the stage

TABLE I

COMPARISON OF THE DIGESTIBILITY OF FEEDS BY HORSES AND SHEEP

Kind of Animals	Percentage of Digestibility of				
	Corn	Oats	Clover	Meadow Hay	Wheat Straw
Horses	89	67	51	51	23
Sheep	89	71	56	64	48

of growth affects the digestibility of the dry matter of plants. At one time it was thought that salt aided in digestion. Although common salt is necessary to meet the demands of the animal body, its presence in the ration seems to have no effect upon the digestion of the feed eaten.

Condimental stock feeds, which usually contain a large percentage of salt, are claimed by many persons to promote digestion. Thorough experimental tests, however, indicate that under normal conditions digestion is not affected by these feeds.

25. Species of Animal.—The different classes of farm animals do not differ materially in the completeness with which they digest concentrated feeds, because this class of feeds appears to be digested as thoroughly by pigs and horses as by cattle and sheep. Bulky, coarse feeds, however, are not so easily digested by pigs and horses as by cattle and sheep. Essential facts brought out in trials conducted by Doctor Wolff, an eminent German scientist, are given in Table I and furnish reliable data on this subject.

26. Palatability of Feed.—It is reasonable to believe that a palatable ration is more thoroughly digested than one that is not palatable. A ration possessing an agreeable odor or flavor starts the flow of digestive juices more quickly than one not having these qualities. It is a matter of common experience that even the thought of food makes a hungry man's mouth water. However, there does not appear to be any digestion trials covering the effects of palatability of feeds on their digestibility.

27. Preparation of Feed.—The digestibility of such feeds as corn, wheat, and oats is increased from 6 to 8 per cent. if they are ground before they are fed to horses or cattle; but their digestibility is not so affected by grinding if they are fed to sheep. It is the general opinion of feeders that the grinding of corn and other grains increases their digestibility for pigs.

The practicability of grinding the feed on the farm depends upon the facilities for doing the work, the availability of the power, and the extent of the feeding operations. If the grinding costs more than one-tenth the value of the feed, the grinding is of very doubtful economy.

Experiments uniformly condemn the cooking of feed for livestock. The digestibility is generally lowered instead of raised; the protein constituents are invariably rendered less digestible; cooking, however, sometimes improves the palatability of rations, and is practiced to some extent by feeders who are fitting animals for exhibition purposes. In such cases, however, the cost of the feed is not an important factor. Although the thoroughness of digestion is not appreciably

affected, some successful feeders claim that slightly better results are obtained by the cooking of hard, dry grain before it is fed to pigs than if it is fed dry. However, rations should usually be fed in a dry condition. Exceptions to this rule may be made as stated above and when fattening cattle are fed hard, dry corn on pasture.

The use of sloppy feeds for all classes of livestock, even for hogs, is becoming less popular with practical feeders all the time.

28. Quantity of Ration.—A review of the results of experiments on the effects of the quantity of a ration on its digestibility indicates that a half ration is a little more thoroughly digested than a normal full ration, but that the difference is not great. However, this question is not of sufficient importance to be considered practical by feeders. It would be poor economy and judgment, for example, to feed a fattening steer scarcely more than a maintenance ration in an effort to secure maximum digestion. Likewise, an experienced feeder will have more important reasons for not overfeeding than a possible saving in the feed itself.

29. Frequency of Feeding.—Frequency of feeding does not affect digestibility when natural limits, in regard to the quantity of a daily ration, are observed.

CLASSIFICATION OF FEEDS

CONCENTRATES

30. Feedstuffs can be conveniently divided into two general classes: concentrates and roughage. All grains, seeds, and by-products that are used as feeds are included in the general class known as concentrates. Feeds belonging to this class yield a larger proportion of digestible nutrients than the feeds of the other class and are an efficient source of feed for animals. The richness and high digestibility of concentrates make them the chief dependence of the feeder who is seeking rapid gains in the feeding pen, a large milk flow in the dairy, or spirit and working capacity in horses. The proportion of concentrate feeds that should be supplied in a ration depends upon the class of animal that is being fed, and on whether or not the ration is merely one for maintenance or is a full ration.

About 73 per cent. of the composition of the cereal grains—corn, wheat, oats, rye, and barley—is carbohydrates, as may be learned by referring to Table II. Another characteristic of the cereals is their low content of protein. Corn, which is the lowest in this respect, has 10.3 per cent. of protein, and barley, which is the highest, contains but 12 per cent. These grains are excellent for fattening purposes, but if fed alone they are not well suited to produce growth or a large flow of milk. Cottonseed and flaxseed have more protein and less carbohydrates than have the other grains listed in Table II, but, due to the fact that they are used commercially as a source of vegetable oils, these seeds are seldom used whole as feeds.

31. By-product feeds are the by-products that occur in the manufacture of vegetable oils, glucose, corn starch, flour, alcoholic liquors, etc. At one time all of these by-products were wasted, but since their value as livestock feed has been

demonstrated by experience and experiment they command a high price in the market.

The chief characteristic of many of the by-product feeds is their richness in protein, for which reason they are often referred to as protein feeds. Another term that is commonly used in designating them is *supplemental feeds*, which is an appropriate term, because their chief function in any ration is to supplement other feeds. They are known also as *commercial by-product feeds*. As has been stated, corn is low in the percentage of protein that it contains, but when an equal quantity of shorts or middlings is added to the corn the ration is much better balanced in its composition than the ration of corn only, and on account of this fact the supplemental feeds are widely used and greatly needed wherever corn is the chief grain crop. Although some of the by-products are extremely rich in protein, others contain scarcely more than do the common grains.

The most common by-product feeds that contain more than 30 per cent. of protein are: blood meal, or dried blood, 84.4 per cent.; tankage, 53.9 per cent.; cottonseed meal, 45.3 per cent.; old-process linseed meal, 33.9 per cent.; gluten meal, 33.8 per cent.; dried distiller's grains, 31.2 per cent. Those that contain from 20 to 30 per cent. of protein are: malt sprouts, 26.3 per cent.; gluten feed, 25 per cent.; dried brewer's grains, 25 per cent.; germ oil meal, 21.7 per cent. By-product feeds containing less than 20 per cent. of protein are: wheat middlings, 16.9 per cent.; shorts, 16.9 per cent.; wheat bran, 15.4 per cent.; rye bran, 14.6 per cent.; rye middlings, 14.3 per cent.; corn bran, 11.2 per cent.; hominy feed, 10.5 per cent.

32. All the feeds just mentioned except blood meal and tankage have their origin in the grains. Blood meal and tankage are by-products of the slaughter houses. Blood meal, the richest feed in protein, is simply dried blood. Tankage is the leavings of the grease tanks, scraps of meat, and bone waste, some blood, and the residue left after evaporating certain of the liquid wastes. This material is cooked under high steam pressure until it is thoroughly disintegrated, after which it is

dried and ground. Tankage is used extensively as a hog feed, but is not considered palatable for other classes of livestock.

The value of commercial by-product feeds is determined chiefly by the quantity of protein they contain, and when they are intelligently used as livestock feed they are a means of securing large and economical results. However, judgment must be exercised in their purchase and use; they are usually high priced and, therefore, the practical feeder should reduce his purchases of them to a minimum. In fact, he should dispense with their use whenever possible. This can often be done by growing protein feeds on the farm. With a liberal supply of such feeds as soybeans, cowpeas, Canada field peas, clovers, and alfalfa it is often possible to dispense with the use of by-product feeds.

ROUGHAGE

DRY ROUGHAGE

33. The three general classes of dry roughage used as livestock feed are hays, straws, and fodders. As compared with the concentrates, all roughage feeds are more bulky in nature, less digestible, and, therefore, are not so efficient as furnishers of materials for the production of energy, growth, fat, or milk. They usually are the stalks of the plants from which the seed has been removed. Their low digestibility is due to the large proportion of crude fiber, or woody matter, that they contain. Though ranking low in feed value, they constitute an essential and necessary part of every ration for all farm animals, except perhaps for pigs. A large part of the ration for ruminants must be in the form of roughage, for a certain degree of bulk in their feed is necessary to insure good digestion and to prevent the consumption by the animal of an excess of nutrients. The large digestive capacity of ruminants makes it possible, in many cases, for the ration to be made up largely of coarse feed. On account of the difference in the digestive capacity of the animals, less roughage is used for horses and pigs than for ruminants. The abundance and the comparative cheap-

ness of roughage on most farms make it highly desirable that the feeder use all such feeds as completely as possible on the farm.

34. Hays.—The hays represent the most valuable roughage for feeding purposes. They are of two classes, namely, leguminous and non-leguminous. The leguminous hays have, on an average, a higher feed value, are more digestible and usually more palatable when properly cured, and contain a larger proportion of protein than the non-leguminous hays. The high percentage of protein in cowpea, in soybean, and in other leguminous hays is shown in Table II. As leguminous hays contain more protein and less carbohydrates than non-leguminous hays, the former are particularly valuable when fed with corn or other feeds that contain small percentage of protein. The quantity of protein that leguminous hays contain guarantees a high fertilizing value to the manure of the animals to which the hays are fed. There can be no well-directed or wise system of cropping established on farms that does not include some legume in the crop rotation, and experience and scientific investigation both indicate that leguminous hay should be fed on the farm where it is grown.

Timothy hay and prairie hay are largely used for the feeding of horses. The freedom of these hays from dust makes them safer than most of the leguminous hays for this class of animal. Clover and alfalfa hays are very desirable feeds for breeding cattle, all classes of sheep, cows in milk, and fattening steers. When these hays are clean and free from dust, they are valuable, also, for colts. Soybean and cowpea hays seem to be particularly suitable for fattening and breeding sheep and are valuable, also, in rations for milch cows.

35. Straws.—The straws are the lowest of the roughages in feed value. Their high content of crude fiber makes them hard to digest and reduces their palatability. However, straws are of some use as livestock feed. Ruminants that are to be carried through the winter on merely a maintenance ration can make large use of straw. Idle horses can also be fed some of this material to advantage.

36. Fodders.—Most of the fodder available for livestock feed has its origin in the corn plant. Corn fodder, or fodder corn, is the entire corn plant after drying. Corn stover is corn fodder minus the ears. Shredded corn stover is corn stover that has been passed through a corn shredder.

Due to the popularity of corn as a farm crop, American stockmen depend on it largely for feeding all classes of stock. Field-cured corn fodder, when well cured, constitutes an extremely palatable and a fairly rich feed. For the fattening of steers it is given high rank by the practical feeder. Also, experiments indicate that cattle seem to do well when a portion of their grain is given to them in corn fodder. The leaves and the tips of the stalks are eaten with great relish. Corn fodder loses a considerable part of its feed compounds, however, by weathering and fermentations. Tests by Woll, of the Wisconsin Experiment Station, indicate a loss of dry matter to the extent of from 15 to 20 per cent. of the original weight, and that this loss is of the more easily digested compounds.

Corn stover, whether in the shredded or whole condition, is of rather low feeding value, but, due to its abundance, is an important source of feed for animals that are being carried through the winter with little grain. At the Missouri Experiment Station thin steers were carried through the winter at a loss of only 33 pounds per steer. In these tests the whole stover proved a little more valuable than the shredded stover. Corn fodder and corn stover are most profitably used when fed with clover or alfalfa hay. It has been found by experiment that 25 per cent. of the protein, 39 per cent. of the carbohydrates, and 15 per cent. of the fat of the corn plant is in the stover. The fact that such a large percentage of the protein, carbohydrates, and fat of the corn plant is in the stover is ample reason for utilizing the whole plant for livestock feed, although in some sections of the United States much corn stover is not utilized as feed but is left in the fields unused.

Other plants used extensively for fodder in many parts of America are millets and sorghums. Of these the saccharine varieties of sorghum, which are rich in sugar, make an unusually palatable feed when dried under favorable conditions.

SUCCULENT ROUGHAGE

37. Soiling Crops.—When soiling, that is, the feeding of soiling crops, is practiced extensively, the animals are kept in more or less confinement and the feed is carted or carried to them. Wherever there is an abundance of land that may be used economically for pasture purposes, soiling as a general system of feeding is not common. However, with increased land values and the necessity of large returns from a given area, the feeding of soiling crops is becoming a popular method of feeding. Soiling crops, when given as a supplement to pasturage in the late summer and fall, are particularly useful for sustaining gains in young stock and for preventing a shrinkage in milk flow.

The crops most valuable for soiling purposes are field corn, sweet corn, sorghum, millets, rape, rye, oats, wheat, alfalfa, the clovers, cowpeas, soybeans, and vetch. It is desirable that these crops be fairly well matured before they are cut, as the immature plants are mostly water and often have an injurious effect on the digestive system of an animal.

38. Silage.—Silage may be defined as feed which has been stored in such a manner that its green or fresh condition is preserved. Green clover, alfalfa, cowpeas, sorghum, and other forage crops have been stored successfully in the silo. But the great American crop preeminently suited for the making of silage is the corn plant. Recent tests have shown that it is usually unprofitable to make silage out of a crop that can be successfully cured and stored in the mow without danger of excessive fermentation. The pithy stalk of the corn plant prevents it from drying and being handled in the same way as the hollow-stalked hays and straws.

The feeding value of corn silage was first demonstrated by feeding it to dairy cows. For milk production, succulence in the ration is almost indispensable, and with corn silage for winter feeding the good effects of the succulent pasture grass during the summer are extended through the winter. Experiments at the Purdue University, Indiana, and the Missouri Agricultural Experiment Stations have recently proved the

economy and value of corn silage in the winter ration of fattening steers. All the tests so far conducted to show the safety and profit of feeding silage to fattening lambs have been favorable to its use. Breeding ewes at the Purdue University Agricultural Experiment Station farm have been largely maintained during the winter on corn silage and clover hay. A recent experiment at the Pennsylvania Agricultural Experiment Station indicates that silage can be successfully fed to horses that are being fattened for the market. For the winter feeding of breeding cows and of calves, silage has proved a great boon.

The value of corn silage as a feed is largely due to its succulence, which is an essential quality of rations for most classes of farm animals. For young stock generally which eat bulky rations, it promotes that sappy, thrifty condition which is associated with rapid growth and quick maturity. A second reason for the increasing popularity of this feed on the stock farm is its economy, or cheapness. The feeding value of the corn plant is preserved more fully in the silo than when put up as shock corn, or corn fodder. The average loss in the feeding value of shock corn by weathering and fermentation is about 20 per cent.; in the silo the loss is usually no more than 15 per cent. The silo makes it possible for the entire corn plant to be preserved in a green, succulent condition, and as at least one-third of its feeding value is found outside the ear, the silo is certain to remain a fixture throughout the changes to more intensive or careful methods of farming.

39. Root Crops.—The roots ordinarily grown for feed are mangels, sugar beets, rutabagas, and carrots. Horses prefer carrots; sheep, common turnips and rutabagas; and for cattle mangels are very appropriate. In England and Scotland, roots are largely depended on for all classes of livestock, especially for cattle and sheep. In fact, in those countries roots constitute the greatest part of the daily rations for livestock; but in America roots are not grown extensively for the feeding of livestock. This is due chiefly to the amount of labor required to grow and harvest a root crop; and to the fact that corn is so extensively grown and made into silage,

1 pound of the dry matter of which is practically equal in feeding value to 1 pound of the dry matter of roots. However, professional herdsmen who are fitting stock for exhibition usually prefer roots to silage. A large percentage of all root crops is water and their chief value as feed lies in their cooling, succulent properties, to their palatability, and to the digestibility of the dry matter that they contain.

According to experiments conducted in Denmark, 1 pound of dry matter in roots is equivalent in feeding value to that of 1 pound of dry matter in corn, wheat, oats, or barley for feeding to cows in milk.

SELECTION AND USE OF FEEDS

BALANCED RATIONS

40. Feeding Standards.—The object of the study of the principles of feeding is to make it possible for farmers and stockmen to feed their livestock in a manner to satisfy all the physiological demands of animals and, at the same time, to do it economically. A **feeding standard** shows the experimentally established quantities of dry matter, digestible protein, digestible carbohydrates, and digestible fat that are necessary to satisfy the physiological requirements per day per 1,000 pounds of live weight of animals under specified conditions.

Thus, the Wolff-Lehmann feeding standards, given in Table IV, show that a dairy cow weighing 1,000 pounds and giving 22 pounds of milk should receive 29 pounds of dry matter, $2\frac{1}{2}$ pounds of digestible protein, 13 pounds of digestible carbohydrates, and $\frac{1}{2}$ pound of digestible fat for each 24 hours. This standard is the result of experiment and scientific investigation, which has shown that a daily ration supplying the above quantities and kinds of digestible nutrients to a 1,000-pound cow will maintain on an average, a milk flow of 22 pounds a day. All the other standards in the table have been derived in the same manner.

In actual practice, these feeding standards can never be used for more than general guides, because, even if the stand-

ards truly satisfied the physiological demands per 1,000 pounds of live weight of animals for 24 hours, which many of the original standards worked out by Wolff and later revised by Lehmann are not supposed to do, they take note only of the chemistry of the feeds, and do not consider the palatability or cost of the feeds, two very important points to the feeder.

These feeding standards have been widely and generally used in America as a guide in practical feeding operations. They are the work of two German scientists, Wolff and Lehmann, performed at a time when facilities for accurate scientific determinations were extremely meager. Their labors deserve high honor and regard, but the findings of modern investigators in animal nutrition, as well as practical feeding tests, have shown that most of these standards are in need of further revision. However, they are the only comprehensive standards for the several classes of animals available for the student, and the standards will be of service in practical feeding operations if too much is not expected of them.

41. Nutritive Ratio.—A **nutritive ratio** is the ratio of the digestible protein to the digestible carbohydrates and fat in any feed or ration. In computing the nutritive ratio of a ration, the amount of digestible fat is multiplied by 2.25 and the product added to the amount of digestible carbohydrates, and the sum divided by the amount of digestible protein. The ratio of one to the quotient is the nutritive ratio. To illustrate: What is the nutritive ratio of a ration furnishing 2.5 pounds of digestible protein, 15 pounds of digestible carbohydrates, and .5 pound of digestible fat?

The calculation is usually made as follows: $.5 \times 2.25 = 1.125$; $1.125 + 15 = 16.125$; $16.125 \div 2.5 = 6.45$. The nutritive ratio is, therefore, 1 part of protein to 6.45 parts of carbohydrates and fat, or 1 : 6.45.

NOTE.—Some authorities on feeding multiply the quantity of fat by 2.4 in computing a nutritive ratio, but recent experiments and investigations show that 2.25 is a more nearly correct factor to use.

The nutritive ratio is wide or narrow according to the proportion of protein that the ration contains. If the relative

amount of protein in a ration is large, it is said to have a narrow nutritive ratio, and if the relative amount of portein is small it is said to have a wide nutritive ratio. A ratio of 1 to 5.5 or less is considered narrow; a ratio of 1 to 8 and above is considered wide; between these two the nutritive ratio is medium. Young growing animals generally and cows giving milk need a large amount of protein, and should therefore receive a ration that has a narrow nutritive ratio. Fattening animals thrive well on wide rations, but pregnant animals and horses at work should receive rations of a medium nutritive ratio.

42. Making Up a Balanced Ration.—By the aid of Table III, which gives the total dry matter and the digestible nutrients contained in 100 pounds of the different feedstuffs, and the number of pounds of each of the digestible nutrients, the nutritive ratio may be determined of almost any ration that may be fed. As the supply of digestible protein in the average ration in use, especially throughout the corn belt, is usually below the requirements of the animal to which the rations are fed, it is frequently desirable and necessary to determine how closely a given ration comes to satisfying the feeding standards given in Table IV. For example, suppose cows that are giving about 20 pounds of milk daily are receiving the following ration per day: 10 pounds of clover hay, 35 pounds of corn silage, 3 pounds of wheat bran, and 3 pounds of oats. How nearly does this ration conform to the standard?

The standard ration for cows giving 22 pounds of milk daily is as follows:

Dry Matter Pounds	Digestible Nutrients			Nutritive Ratio
	Protein Pounds	Carbohydrates Pounds	Fat Pounds	
29	2.5	13	0.5	1 to 5.7

According to Table III, 100 pounds of Red-clover hay contains 84.7 pounds of dry matter, 7.1 pounds of digestible protein, 37.8 pounds of digestible carbohydrates, and 1.8 pounds

of digestible fat. Ten pounds of clover hay, therefore, contains one-tenth of these quantities of nutrients, or the following: 8.47 pounds of dry matter, .71 pound of digestible protein, 3.78 pounds of digestible carbohydrates, and .18 pound of digestible fat. One hundred pounds of corn silage contains 26.4 pounds of dry matter, 1.4 pounds of digestible protein, 14.2 pounds of digestible carbohydrates, and .7 pound of digestible fat. One pound of corn silage, therefore, contains one-hundredth of these quantities and 35 pounds contains 35 hundredths, or .35. Dividing the amount of each nutrient, then, by 100 and multiplying by 35 gives 9.24 pounds of dry matter, .49 pound of digestible protein, 4.97 pounds of digestible carbohydrates, and .245 pound of digestible fat, which are the nutrients contained in 35 pounds of corn silage. In the same way the nutrients contained in 3 pounds of wheat bran and 3 pounds of oats are determined.

All such data are set down in tabular form, as follows, and the total dry matter and the total of each nutrient is determined by adding the numbers in each column and the nutritive ratio is computed as explained in Art. **41.**

Feeds	Dry Matter Pounds	Digestible Nutrients			Nutritive Ratio
		Protein Pounds	Carbohydrates Pounds	Fat Pounds	
10 pounds clover hay	8.470	.710	3.780	.180	
35 pounds corn silage	9.240	.490	4.970	.245	
3 pounds wheat bran	2.643	.357	1.260	.075	
3 pounds oats	2.688	.321	1.509	.114	
Total	23.041	1.878	11.519	.614	1 to 6.86

43. As compared with the standard, the above ration is lacking in amount of dry matter and in total digestible nutrients. It is also deficient in the proportion of digestible protein contained, as the nutritive ratio is too wide. It may be noted that the quantity of fat is greater than is required by the standard, but as the function of fat and carbohydrates is the

same, it is only necessary, in making up a balanced ration, that the sum of the carbohydrates plus the fat multiplied by 2.25 be approximately the same as the sum of these nutrients, computed in a like manner, is in the standard ration. In fact, it is very difficult to make up a balanced ration from American feedstuffs and not have the quantity of fat in excess of that called for by the Wolff-Lehmann standards. To correct the ration the totals of its dry matter and digestible nutrients are set down as in the following tabular form, and beneath them are placed, for trial correction, the quantities of dry matter and digestible nutrients of 5 pounds of Red-clover hay and 1 pound of cottonseed meal. The totals of the dry matter and the digestible nutrients of the corrected ration are then found and the nutritive ratio computed.

Feeds	Dry Matter Pounds	Digestible Nutrients			Nutritive Ratio
		Protein Pounds	Carbohydrates Pounds	Fat Pounds	
Original ration.....	23.041	1.878	11.519	.614	1 to 6.86
5 pounds clover hay ...	4.235	.355	1.890	.090	
1 pound cottonseed meal	.930	.376	.214	.096	
Corrected ration...	28.206	2.609	13.623	.800	1 to 5.91

The corrected ration, consisting of 15 pounds of clover hay, 35 pounds of corn silage, 3 pounds of wheat bran, 3 pounds of oats, and 1 pound of cottonseed meal, conforms very closely with the standard. The above ration will, therefore, satisfy the daily demands of a 1,000-pound dairy cow giving on an average about 20 pounds of milk a day.

44. The same procedure may be followed in all determinations of this kind. The value of such calculations to the feeder is not only to acquaint him with the wide variations in the demands and requirements of the different classes of livestock, but to increase his knowledge of the chemical composition of feeds. With a knowledge of feeding standards and of the chemical composition of feeds the stockman is enabled

to combine feeds so that they satisfy the needs of animals, or, in other words, to feed a balanced ration. This is the first and a most fundamental principle of feeding.

The feeding standards given in Table IV shows the requirements of 1,000 pounds live weight of animal or of animals. An animal weighing 1,500 pounds would naturally be supposed to require one-half more feed; but this is not the case, as has been proved by experiments. The smaller the animal, other things being equal, the greater is its demand for feed in proportion to its size. In the feeding of steers, the feeder should add, for each 100 pounds that a steer weighs over 1,000 pounds, about 5.6 per cent. of the quantity of dry matter called for by the standard. Thus, the feeding standard shows that a fattening steer weighing 1,000 pounds should receive 26 pounds of dry matter. A fattening steer weighing 1,500 pounds should receive not 50 per cent. more than 26 pounds, or 39 pounds of dry matter, but 5.6 per cent. more for each 100 pounds that the steer weighs over 1,000 pounds, or a total of 28 per cent. more than 26 pounds, or 33.28 pounds of dry matter.

MISCELLANEOUS FACTORS AFFECTING THE SELECTION AND USE OF FEEDS

45. Although the chemical composition of a feed is a guide to its use, it is not the only factor that must be considered in selecting feeds and making up rations. The suitability and economy of any ration to produce growth or milk production is determined by its *palatability*, its *physiological effects* on the animal to which it is fed, and its *cost* or *availability*, as well as by the balance of its chemical nutrients.

46. Palatability.—Palatability is one of the most essential qualities of a good ration. The ration must be eaten with a relish or good results will not be obtained. If not palatable, sufficient feed will not be eaten for large yields in flesh, in milk, or in other respects, and large yields are essential to profit. As far as possible, the likes and dislikes of animals should be considered and catered to.

Palatability of rations is secured in several ways, which are, briefly, by the rejection of feed that is dirty, moldy, musty, sour, or tainted by being left over from one feeding period to the next; by giving attention to variety of feeds in any ration; by supplying more liberally of protein and succulence than is ordinarily fed; by always feeding within the capacity of the animal, or in being careful not to overfeed; and by keeping the stables in a sanitary condition and the feed boxes clean.

It is self-evident that good results cannot be secured when the feed is moldy, soured, or tainted, but failure in securing good results is often traced to a lack of appreciation of this one detail. Sickness and lack of appetite are often brought about by supplying feed that is not clean and sweet. It is folly to try to get animals to do well when their rations are not placed before them in a wholesome, attractive condition and free from any taint or objectionable odor.

A combination of feeds is usually more palatable than a single feed and its effect on gains or in milk production is particularly noticeable. It has often been demonstrated by experiment that two feeds, equal and similar in composition, give better results when fed in combination than when either is fed alone.

47. A balanced ration is always more palatable than one lacking balance, other things being equal. The good results obtained by feeding rations that contain protein supplements are often due more to their effect on palatability than on the part they play in balancing the ration. Succulence increases the palatability of a ration, and observation indicates that many rations are not eaten with relish because they are dry and hard. The value of pasture grass, roots, and silage is partly due to this quality of succulence.

The successful feeder is careful not to overfeed. He feeds no more at any one time than will be cleaned up in a reasonable time. He brings his animals up to full feed gradually and always regulates the amount fed by the appetite and behavior of the animal at feeding time. Feed always tastes best to an animal when it is hungry, and the secret of many a successful feeder is his ability so to regulate the supply of feed as to keep

the appetite on edge and the animals anxious for their rations at feeding time.

Dirty feed boxes and damp, unsanitary quarters depress the appetite and taint the feed. The ration, to be palatable, must be supplied in clean troughs or boxes, and the environment of animals must be such as to conduce to their comfort and contentment. Good feeding necessitates close observation and appreciation of all conditions that have an influence on the palatability of feed and the appetite of an animal.

48. Physiological Effects of Feed on Animals.—Feeds should be selected and rations made up with regard to their effects on the digestive system and on the condition of the droppings of the animals. The character of the droppings is an indication of the condition of digestion. When the digestive system is in a normal, healthy condition, the bowels are loose. Constipation, or the opposite condition, scours, is a sign that something has gone wrong in digestion. A fairly loose, open condition of the bowels reflects a healthy condition of the digestive tract and tone in the general system, and indicates the thorough and efficient use of the feed supplied. A thin, sour condition of the droppings usually indicates something wrong in the feeding or in the selection of the feeds and always results in a waste of feed and a weakening of the organs of digestion.

Rations that are extremely dry in character and lacking in a variety of feeds are usually too binding, or constipating, to give good results. On the other hand, very immature green pastures early in the season cause a too loose, or laxative, condition for good results. The fact that some feeds tend to cause constipation and others tend to correct this condition by being laxative in their effects makes a knowledge of these properties important to the feeder. Many feeds are not pronounced in their effects either way. As a rule, cottonseed meal, wheat straw, very dry timothy hay, and corn stover have a tendency to cause constipation. Linseed meal, flaxseed meal, wheat bran, good quality of clover and alfalfa hay, and succulence in the form of green grass, silage or root crops are

recognized as being laxative in their effects. Wheat bran and linseed meal, although normally laxative in their effects, seem to possess the property that will enable them to correct either constipation or a loose condition of the bowels.

The importance of constant observation of the relation of individual feeds to the consistency of the droppings is a point in successful feeding demanding special attention. In a feed yard, many other conditions, independent of the kind of feeds supplied, combine to cause scours. Overfeeding, irregular feeding, nervous disturbances, unaccustomed exercise, extreme heat, and bad water all may have a particular effect in causing scours.

49. Cost or Availability of Feed.—The matter of cost in the selection of feeds is of great importance in practical feeding operations. As a rule, livestock is kept as a medium for marketing the crops grown on the farm and the rations fed should be made up from this supply to as large an extent as is possible and consistent with good results. Other things being equal, the available and home-grown feeds should always be given the preference over purchased feeds. An expensive ration may give excellent results in gains or in the production of milk, but the results may not be profitable. To make a profit from feeding operations is the chief purpose of feeders, and many desirable feeds must often be excluded from the ration because their high cost makes their use prohibitive.

The importance of the cost of feeds in determining profit must be considered in making up a balanced ration. Since it is the commercial protein feeds that most farmers need to balance their rations of home-grown feeds, the cost of the commercial protein feeds must be considered of equal importance with their composition. Because of their high cost, the purchase of such feeds should be reduced to a minimum; but because of the necessity of feeding a ration that is fairly well balanced, the average ration must be supplemented by the purchase and use of such feeds as oil meal, cottonseed meal, middlings, etc., or by an increase in the home production and consumption of leguminous crops like clover, alfalfa, soybeans, or cowpeas.

FEEDING TABLES

TABLE II

AVERAGE COMPOSITION OF AMERICAN FEEDSTUFFS

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Acorns	55.3	1.0	2.5	4.4	34.8	1.9
Alfalfa, green	71.8	2.7	4.8	7.4	12.3	1.0
Alfalfa hay, grown in Eastern U. S.	6.4	8.6	16.3	27.1	39.2	2.4
Alfalfa hay, grown in Western U. S.	6.8	10.6	15.4	33.3	32.5	1.4
Alfalmo	9.1	11.2	13.1	22.4	42.1	2.1
Alsike clover, green	74.8	2.0	3.9	7.4	11.0	0.9
Alsike clover hay	9.7	8.3	12.8	25.6	40.7	2.9
Apple pomace	83.0	0.6	1.0	2.9	11.6	0.9
Apples	80.8	0.4	0.7	1.2	16.6	0.4
Artichokes	79.5	1.0	2.6	0.8	15.9	0.2
Australian salt bush, green	75.8	5.8	3.5	3.9	10.5	0.5
Australian salt-bush hay	9.2	21.7	12.9	14.7	39.6	1.9
Bagasse, sorghum	11.4	2.9	3.4	30.5	50.4	1.4
Bakery refuse	13.0	10.1	8.0	0.3	63.0	5.6
Bald barley hay	6.9	8.7	5.4	23.2	53.9	1.8
Banana butts, dried	13.5	3.6	6.4	38.6	35.5	2.4
Banana tops, dried	6.4	4.1	13.2	31.9	42.1	2.3
Barley and peas, green	80.0	1.6	2.8	6.8	8.2	0.6
Barley and vetch, green	80.0	1.2	2.8	6.5	9.0	0.5
Barley feed	8.9	4.4	13.8	9.1	59.9	3.9
Barley fodder, green	79.0	1.8	2.7	7.9	8.0	0.6
Barley, grain	10.8	2.5	12.0	4.2	68.7	1.8
Barley hay, cut in milk	5.0	4.2	8.8	24.7	44.9	2.4
Barley screenings	12.2	3.6	12.3	7.3	61.8	2.8
Barley straw	14.2	5.7	3.5	36.0	39.0	1.5
Barnyard millet, green	75.0	1.9	2.4	7.0	13.1	0.6
Barnyard millet hay	14.9	7.9	10.6	27.8	37.1	1.7

NOTE.—Tables II, III, and IV are compiled largely from Henry's "Feeds and Feeding."

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Bean, horse, green	84.2	1.2	2.8	4.9	6.5	0.4
Bean, horse, straw....	9.2	8.7	8.8	37.6	34.3	1.4
Bean meal.....	10.9	5.7	23.2	3.8	54.9	1.5
Bean, velvet, green ...	82.2	1.9	3.5	5.1	6.6	0.7
Bean, velvet, hay.....	10.0	5.9	14.0	37.7	30.6	1.8
Beans, cull.....	10.9	5.7	23.2	3.8	54.9	1.5
Beans, horse.....	11.3	3.8	26.6	7.2	50.1	1.0
Beech twigs, dried, gathered in winter ..	15.3	2.6	4.0	38.5	38.0	1.6
Beet leaves, sugar.....	88.0	2.4	2.6	2.2	4.4	4.0
Beet molasses.....	20.8	10.6	9.1		59.5	
Beet pulp, dry.....	8.4	4.5	8.1	17.5	60.8	0.7
Beet pulp, wet.....	89.6	0.6	0.9	2.4	6.3	
Beets, common.....	88.5	1.0	1.5	0.9	8.0	0.1
Beets, sugar.....	86.5	0.9	1.8	0.9	9.8	0.1
Beggar-weed hay	9.2	4.7	11.8	29.3	42.1	2.9
Bermuda grass.....	71.7	2.1	2.2	5.9	17.2	0.9
Bermuda-grass hay ...	6.9	3.5	10.7	51.0	25.0	2.9
Blackstrap molasses...	22.4	9.3	2.4		65.9	
Blood, dried.....	8.5	4.7	84.4			2.5
Blue joint hay.....	6.9	5.5	11.2	37.2	35.8	3.4
Bone-and-meat meal .	6.0	37.4	39.5		6.3	10.8
Bone, fresh.....	34.2	22.8	20.6		1.9	20.5
Bone, raw, ground....	8.0	64.4	23.9		3.4	0 3
Bran, corn.....	9.4	1.2	11.2	11.9	60.1	6.2
Bran, spring-wheat ...	11.0	6.2	15.7	9.8	52.4	4.9
Bran, wheat, all analyses.....	11.9	5.8	15.4	9.0	53.9	4.0
Bran, winter-wheat ...	11.5	6.4	15.7	8.7	53.4	4.3
Brewers' grains, dry ..	8.7	3.7	25.0	13.6	42.3	6.7
Brewers' grains, wet ..	75.7	1.0	5.4	3.8	12.5	1.6
Broom-corn seed.....	12.8	2.8	9.9	7.0	64.3	3.2
Broom-sedge hay	6.6	6.4	4.7	38.7	42.3	1.4
Buckwheat bran.....	8.2	4.9	12.6	32.9	37.9	3.5
Buckwheat feed.....	11.6	3.9	18.3	19.2	42.1	4.9
Buckwheat flour.....	14.6	1.0	6.9	0.3	75.8	1.4
Buckwheat, grain.....	13.4	2.0	10.8	11.7	59.7	2.4

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Buckwheat hulls	13.2	2.2	4.6	43.5	35.3	1.1
Buckwheat middlings	12.8	5.0	26.7	4.4	44.3	6.8
Buckwheat straw	9.9	5.5	5.2	43.0	35.1	1.3
Buffalo-grass hay	15.0	8.8	4.9	19.7	48.4	3.2
Bur-clover, green	73.8	2.3	5.5	5.9	10.5	2.0
Bur clover hay	9.0	5.0	13.6	30.6	38.2	3.6
Buttercup hay	9.3	5.6	9.9	30.6	41.1	3.5
Buttermilk	90.1	0.7	4.0		4.0	1.1
Cabbage	90.0	0.8	2.6	0.9	5.5	0.2
Cacti, cane, green	78.5	3.6	1.4	3.6	12.3	0.6
Canada blue-grass hay	14.3	4.5	7.6	21.7	49.0	2.9
Canada field peas, green	84.7	1.3	2.8	4.4	6.3	0.5
Canada field peas, seeds	15.0	2.4	23.7	7.9	50.2	0.8
Carrots	88.6	1.0	1.1	1.3	7.6	0.4
Cassava	66.0	0.7	1.1	1.8	30.2	0.2
Cassava starch refuse	12.0	1.6	0.8	6.1	78.8	0.7
Chaff, oat	14.3	10.0	4.0	34.0	36.2	1.5
Chaff, wheat	14.3	9.2	4.5	36.0	34.6	1.4
Cheat hay	8.4	6.9	8.0	26.4	48.3	2.0
Chufa	79.5	0.4	0.7	2.2	10.5	6.6
Clovers and grasses, mixed, green	75.0	1.6	2.9	8.0	11.7	0.8
Clovers and grasses, mixed, hay	12.9	5.5	10.1	27.6	41.3	2.6
Cocoanut cake	10.3	5.9	19.7	14.4	38.7	11.0
Colorado River hemp seed	9.2	3.3	31.7	13.5	37.9	4.3
Colostrum	74.6	1.6	17.6		2.7	3.6
Comfrey, prickly	88.4	2.2	2.4	1.6	5.1	0.3
Common beets	88.5	1.0	1.5	0.9	8.0	0.1
Common little sage	35.0	4.3	13.7	14.3	30.3	2.4
Common millet, green	80.0	1.0	1.5	6.5	10.5	0.5
Common sage	49.6	3.6	4.6	11.3	20.3	10.5
Corn-and-cob meal	15.1	1.5	8.5	6.6	64.8	3.5
Corn bran	9.4	1.2	11.2	11.9	60.1	6.2
Corn cob	10.7	1.4	2.4	30.1	54.9	0.5

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Corn, dent, grain	10.6	1.5	10.3	2.2	70.4	5.0
Corn, flint, grain.....	11.3	1.4	10.5	1.7	70.1	5.0
Corn fodder, all varieties, green.....	79.3	1.2	1.8	5.0	12.0	0.5
Corn fodder, dent, kernels glazed, green...	73.4	1.5	2.0	6.7	15.5	0.9
Corn fodder, dent varieties, green.....	79.0	1.2	1.7	5.6	12.0	0.5
Corn fodder, ears on .	42.2	2.7	4.5	14.3	34.7	1.6
Corn fodder, flint, green.....	79.8	1.1	2.0	4.3	12.1	0.7
Corn fodder, flint kernels glazed, green...	77.1	1.1	2.1	4.3	14.6	0.8
Corn fodder, sweet, green.....	79.1	1.3	1.9	4.4	12.8	0.5
Corn husks, dry	50.9	1.8	2.5	15.8	28.3	0.7
Corn leaves and husks, green.....	66.2	2.9	2.1	8.7	19.0	1.1
Corn leaves, dry.....	30.0	5.5	6.0	21.4	35.7	1.4
Corn meal.....	15.0	1.4	9.2	1.9	68.7	3.8
Corn plants, sweet, green, ears removed.	80.0	1.2	1.4	4.9	12.0	0.5
Corn, pop, grain.....	10.7	1.5	11.2	1.8	69.6	5.2
Corn stalks, stripped, green.....	76.1	0.7	0.5	7.3	14.9	0.5
Corn stover, ears removed.....	40.5	3.4	3.8	19.7	31.5	1.1
Corn, sweet, grain	8.8	1.9	11.6	2.8	66.8	8.1
Cottonseed.....	10.3	3.5	18.4	23.2	24.7	19.9
Cottonseed hulls.....	11.1	2.8	4.2	46.3	33.4	2.2
Cottonseed kernels, without hulls.....	6.2	4.7	31.2	3.7	17.6	36.6
Cottonseed meal.....	7.0	6.6	45.3	6.3	24.6	10.2
Cottonseed, roasted...	6.1	5.5	16.8	20.4	23.5	27.7
Couch-grass hay.....	14.3	6.0	8.8	24.8	43.1	3.0
Cowpea hay.....	10.5	14.2	8.9	21.2	42.6	2.6
Cowpeas, green.....	83.6	1.7	2.4	4.8	7.1	0.4

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Cowpeas, seeds	14.6	3.2	20.5	3.9	56.3	1.5
Crab-grass hay	14.3	10.8	8.4	27.5	36.6	2.4
Crimson clover, green	80.9	1.7	3.1	5.2	8.4	0.7
Crimson-clover hay	9.6	8.6	15.2	27.2	36.6	2.8
Dandelion	84.3	2.2	1.2		8.2	4.1
Distillers' grains, dry	7.6	2.0	31.2	11.6	35.4	12.2
Dried blood	8.5	4.7	84.4			2.5
Dried fish	10.8	29.2	48.4			11.6
Dwarf Essex rape, green	85.7	2.5	2.2	2.1	7.0	0.5
Dwarf Essex rape, summer	85.0	2.8	2.1	2.7	6.9	0.5
Dwarf Essex rape, winter	85.0	3.3	2.3	1.8	7.1	0.5
Emmer, grain	8.4	3.9	11.5	11.1	62.9	2.2
Emmer hay	6.9	11.1	10.7	34.1	35.8	1.4
English hay	14.0	5.3	7.9	27.7	42.8	2.3
Fescue, Meadow, hay	19.2	6.8	7.0	25.9	38.4	2.7
Fescue, Meadow, in bloom	69.9	1.8	2.4	10.8	14.3	0.8
Field peas, Canada, green	84.7	1.3	2.8	4.4	6.3	0.5
Field peas, Canada, seeds	15.0	2.4	23.7	7.9	50.2	0.8
Fish, dried	10.8	29.2	48.4			11.6
Flat-pea hay	8.4	7.9	22.9	26.2	31.4	3.2
Flaxseed	9.2	4.3	22.6	7.1	23.2	33.7
Flax shives	10.0	3.9	5.1	42.7	35.2	3.1
Flour, buckwheat	14.6	1.0	6.9	0.3	75.8	1.4
Flour, red dog	9.9	2.6	18.0	3.0	62.5	4.0
Flour, rye	13.1	0.7	6.7	0.4	78.3	0.8
Flour, wheat	12.4	0.4	12.0		74.0	1.2
Fowl meadow-grass hay	10.1	6.5	8.7	27.9	44.4	2.3
Gama-grass hay	11.8	6.2	6.8	30.4	43.1	1.8
Germ oil meal	8.6	2.4	21.7	8.8	47.3	11.2
Gluten feed	9.2	2.0	25.0	6.8	53.5	3.5

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Gluten meal	9.5	1.5	33.8	2.0	46.6	6.6
Grasses and clovers, mixed, green	75.0	1.6	2.9	8.0	11.7	0.8
Grasses and clovers, mixed, hay	12.9	5.5	10.1	27.6	41.3	2.6
Greasewood	4.6	14.4	19.8	24.5	34.2	2.5
Guinea-grass hay	7.6	3.2	5.5	28.2	54.6	0.9
Hog millet, green	80.0	1.4	1.5	6.5	10.2	0.4
Hominy feed, chop	9.6	2.7	10.5	4.9	64.3	8.0
Horse-bean fodder, green	84.2	1.2	2.8	4.9	6.5	0.4
Horse-bean straw	9.2	8.7	8.8	37.6	34.3	1.4
Horse beans	11.3	3.8	26.6	7.2	50.1	1.0
Hungarian grass	71.1	1.7	3.1	9.2	14.2	0.7
Hungarian-grass hay	7.7	6.0	7.5	27.7	49.0	2.1
Hungarian-grass seed	9.5	5.0	9.9	7.7	63.2	4.7
Italian rye grass, coming in bloom	73.0	2.5	3.1	6.8	13.3	1.3
Italian rye-grass hay	8.5	6.9	7.5	30.5	45.0	1.7
Japan-clover hay	11.0	8.5	13.8	24.0	39.0	3.7
Japanese millet, green	75.0	1.5	2.1	7.8	13.1	0.5
Johnson grass	75.0	1.4	1.2	8.9	13.2	0.3
Johnson-grass hay	10.2	6.1	7.2	28.5	45.9	2.1
Kafir-corn forage	52.1	2.4	2.5	21.0	20.1	1.8
Kafir-corn heads, ground	13.6	2.8	9.2	8.0	63.8	2.6
Kafir corn, red, green	81.6	1.3	1.8	4.8	9.9	0.6
Kafir-corn seed	9.9	1.6	11.2	2.7	71.5	3.1
Kafir corn, white, green	83.4	1.4	1.9	4.6	8.0	0.7
Kentucky blue grass	65.1	2.8	4.1	9.1	17.6	1.3
Kentucky blue-grass hay, all analyses	21.2	6.3	7.8	23.0	37.8	3.9
Kentucky blue-grass hay, cut in milk	24.4	7.0	6.3	24.5	34.2	3.6
Kentucky blue-grass hay, cut ripe	27.8	6.4	5.8	23.8	33.2	3.0

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Leaves of trees, dried, gathered in July....	16.0	7.0	10.5	14.2	49.3	3.0
Linseed meal, new-process.....	9.7	5.5	37.5	8.9	36.4	2.0
Linseed meal, old-process.....	9.8	5.5	33.9	7.3	35.7	7.8
Macaroni-wheat hay..	7.0	6.8	6.8	26.5	51.2	1.8
Malt sprouts.....	9.5	6.1	26.3	11.6	44.9	1.6
Mammoth clover, green.....	80.0	1.9	3.0	5.8	8.9	0.4
Mammoth-clover hay.	21.2	6.1	10.7	24.5	33.6	3.9
Mangels.....	90.9	1.1	1.4	0.9	5.5	0.2
Meadow-fescue hay...	19.2	6.8	7.0	25.9	38.4	2.7
Meadow fescue, in bloom.....	69.9	1.8	2.4	10.8	14.3	0.8
Meadow-foxtail hay...	6.6	9.8	9.3	32.3	38.9	3.1
Meat-and-bone meal .	6.0	37.4	39.5		6.3	10.8
Meat scrap.....	10.7	4.1	71.2		0.3	13.7
Middlings, buckwheat	12.8	5.0	26.7	4.4	44.3	6.8
Middlings, oat.....	8.8	4.5	16.2	7.1	56.5	6.9
Middlings, rye.....	11.8	1.7	14.3	2.4	66.9	2.9
Middlings, standard, wheat.....	11.2	4.4	16.9	6.2	56.2	5.1
Middlings, wheat flour	10.0	3.2	19.2	3.2	59.6	4.8
Milk, cow's.....	87.2	0.7	3.6		4.9	3.7
Milk, goat's.....	86.9	0.9	3.7		4.4	4.1
Milk, ewe's.....	81.3	0.8	6.3		4.7	6.8
Milk, mare's.....	91.0	0.4	2.1		5.3	1.2
Milk, skim, centrifugal	90.6	0.7	3.1		5.3	0.3
Milk, skim, gravity ...	90.4	0.7	3.3		4.7	0.9
Milk, sow's.....	80.8	1.1	6.2		4.8	7.1
Millet, Barnyard, green	75.0	1.9	2.4	7.0	13.1	0.6
Millet, Barnyard, hay.	14.9	7.9	10.6	27.8	37.1	1.7
Millet, Cattail, hay...	11.0	8.1	11.6	26.8	40.2	2.3
Millet, Common, green	80.0	1.0	1.5	6.5	10.5	0.5
Millet, Hog, green....	80.0	1.4	1.5	6.5	10.2	0.4
Millet, Japanese, green	75.0	1.5	2.1	7.8	13.1	0.5

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Millet, Pearl, green ...	81.5	1.5	1.2	6.2	9.3	0.3
Millet seed.....	12.1	2.8	10.9	8.1	62.6	3.5
Millet straw.....	15.0	5.2	4.1	34.2	39.7	1.8
Milo maize forage.....	40.9	2.9	2.9	19.1	31.8	2.3
Milo maize heads, ground.....	9.7	2.7	9.2	6.5	69.5	2.4
Milo maize, seed.....	9.0	2.3	10.7	3.0	72.2	2.8
Milo maize, yellow, green.....	83.2	1.5	1.7	5.5	7.5	0.6
Mixed grasses and clover, green.....	75.0	1.6	2.9	8.0	11.7	0.8
Mixed grasses and clover hay.....	12.9	5.5	10.1	27.6	41.3	2.6
Mixed grasses, hay....	15.3	5.5	7.4	27.2	42.1	2.5
Molasses, beet.....	20.8	10.6	9.1		59.5	
Molasses-beet pulp....	7.0	5.5	9.6	16.1	61.3	0.5
Molasses, blackstrap .	22.4	9.3	2.4		65.9	
Molasses grains.....	10.4	6.5	17.1	11.9	51.2	2.9
Molasses, Porto Rico..	25.9	6.3	2.7		65.1	
New corn product	8.8	4.1	5.2	31.9	47.4	2.6
Oak leaves, dried, gathered in July.....	5.4	9.7	9.5	25.8	45.1	4.5
Oat and pea hay.....	10.5	7.1	10.3	28.3	41.2	2.6
Oat and vetch hay....	15.0	7.4	12.8	26.7	35.8	2.3
Oat chaff.....	14.3	10.0	4.0	34.0	36.2	1.5
Oat dust.....	6.5	6.9	13.5	18.2	50.2	4.8
Oat feed.....	7.0	5.3	8.0	21.5	55.3	2.9
Oat fodder, green.....	62.2	2.5	3.4	11.2	19.3	1.4
Oat-grass hay, tall....	14.0	4.6	6.4	30.9	42.1	1.9
Oat grass, tall, in bloom	69.5	2.0	2.4	9.4	15.8	0.9
Oat hay, cut in milk..	14.4	5.7	8.9	27.4	41.2	2.8
Oat hulls.....	7.4	6.7	3.4	30.7	50.5	1.3
Oatmeal.....	7.9	2.0	14.7	0.9	67.4	7.1
Oat middlings.....	8.8	4.5	16.2	7.1	56.5	6.9
Oat straw.....	9.2	5.1	4.0	38.0	42.4	2.3
Oats and peas, green..	79.7	1.6	2.4	6.1	9.6	0.6
Oats and vetch, green..	80.0	1.8	3.0	6.3	8.4	0.5

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Oats, grain	10.4	3.2	11.4	10.8	59.4	4.8
Orchard grass	73.0	2.0	2.6	8.2	13.3	0.9
Orchard-grass hay	9.9	6.0	8.1	32.4	41.0	2.6
Orchard grass, in bloom	73.0	2.0	2.6	8.2	13.3	0.9
Palmnut cake	10.4	4.3	16.8	24.0	35.0	9.5
Para-grass hay	7.6	3.3	9.1	36.0	42.9	1.1
Parsnips	90.5	0.8	1.1	6.2	1.2	0.2
Pasture grass	80.0	2.0	3.5	4.0	9.7	0.8
Pea and oat hay	10.5	7.1	10.3	28.3	41.2	2.6
Pea bran	11.0	2.7	10.0	39.7	35.6	1.0
Pea meal	10.5	2.6	20.2	14.4	51.1	1.2
Peanut cake	10.7	4.9	47.6	5.1	23.7	8.0
Peanut kernels	7.5	2.4	27.9	7.0	15.6	39.6
Peanut vines, with nuts	6.3	5.6	12.6	27.4	34.0	14.1
Peanut vines, without nuts	7.6	10.8	10.7	23.6	42.7	4.6
Peanuts, with hull	6.6	2.7	23.2	18.4	14.2	35.0
Pearl millet, green	81.5	1.5	1.2	6.2	9.3	0.3
Peas and barley, green	80.0	1.6	2.8	6.8	8.2	0.6
Peas and oats, green	79.7	1.6	2.4	6.1	9.6	0.6
Perennial rye-grass hay	14.0	7.9	10.1	25.4	40.5	2.1
Potato pomace	91.5	0.3	0.7	1.0	6.4	0.1
Potatoes	79.1	0.9	2.1	0.4	17.4	0.1
Prairie hay	9.2	7.8	6.2	34.1	39.9	2.8
Prickly comfrey	88.4	2.2	2.4	1.6	5.1	0.3
Prickly pear	84.2	3.1	0.7	2.4	9.0	0.3
Pumpkin, field	90.9	0.5	1.3	1.7	5.2	0.4
Pumpkin, garden	86.8	0.9	1.8	1.8	7.9	0.8
Purslane	91.0	1.5	2.3	1.6	3.4	0.2
Quack-grass hay	14.3	6.0	8.8	24.8	43.1	3.0
Ragweed, green	61.0	4.4	3.9	13.4	15.2	2.1
Ramie, green	77.9	3.5	2.2	7.1	8.4	0.9
Rape, Dwarf, Essex, green	85.7	2.5	2.2	2.1	7.0	0.5
Rape, Dwarf, Essex, summer	85.0	2.8	2.1	2.7	6.9	0.5

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Rape, Dwarf, Essex, winter	85.0	3.3	2.3	1.8	7.1	0.5
Rape-seed cake	10.0	7.9	31.2	11.3	30.0	9.6
Raw ground bone	8.0	64.4	23.9		3.4	0.3
Red clover, different stages, green	70.8	2.1	4.4	8.1	13.5	1.1
Red-clover hay, all analyses	15.3	6.2	12.3	24.8	38.1	3.3
Red-clover hay, cut in bloom	20.8	6.6	12.4	21.9	33.8	4.5
Red-dog flour	9.9	2.6	18.0	3.0	62.5	4.0
Red Kafir corn, green	81.6	1.3	1.8	4.8	9.9	0.6
Red-top grass, cut in bloom	65.3	2.3	2.8	11.0	17.7	0.9
Red-top hay, cut in bloom	8.7	4.9	8.0	29.9	46.4	2.1
Red-top hay, different stages	8.9	5.2	7.9	28.6	47.5	1.9
Rhode Island Bent grass hay	7.1	6.7	6.1	31.9	46.3	1.9
Rice bran	9.7	9.7	11.9	12.0	46.6	10.1
Rice, grain	12.4	0.4	7.4	0.2	79.2	0.4
Rice hulls	8.8	15.6	3.2	36.2	35.2	1.0
Rice meal	10.2	8.1	12.0	5.4	51.2	13.1
Rice polish	10.5	4.8	11.9	3.3	62.3	7.2
Rice, rough	11.2	4.9	7.3	8.0	66.6	2.0
Rowen hay	14.0	6.4	11.4	23.9	41.3	3.0
Rutabagas	88.6	1.2	1.2	1.3	7.5	0.2
Rye bran	11.8	3.4	14.6	3.5	63.9	2.8
Rye feed, shorts and bran	12.4	3.2	15.7	4.1	61.5	3.1
Rye flour	13.1	0.7	6.7	0.4	78.3	0.8
Rye fodder, green	76.6	1.8	2.6	11.6	6.8	0.6
Rye, grain	8.7	2.1	11.3	1.5	74.5	1.9
Rye grass, coming in bloom, Italian	73.0	2.5	3.1	6.8	13.3	1.3
Rye-grass hay, Italian	8.5	6.9	7.5	30.5	45.0	1.7

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Rye-grass hay, Perennial	14.0	7.9	10.1	25.4	40.5	2.1
Rye hay	9.5	5.7	10.8	32.6	38.7	2.7
Rye middlings	11.8	1.7	14.3	2.4	66.9	2.9
Rye straw	7.1	3.2	3.0	38.9	46.6	1.2
Sage, Common	49.6	3.6	4.6	11.3	20.3	10.5
Sage, Little, Common	35.0	4.3	13.7	14.3	30.3	2.4
Salt bush, Australian, green	75.8	5.8	3.5	3.9	10.5	0.5
Salt marsh-grass hay	10.4	7.7	5.5	30.0	44.1	2.4
Sand vetch, green	85.3	2.1	3.6	4.0	4.6	0.4
Sanfoin, green	75.0	2.1	4.4	6.0	11.6	0.9
Sanfoin hay	15.0	7.3	14.8	20.4	39.5	3.0
Screenings, barley	12.2	3.6	12.3	7.3	61.8	2.8
Screenings, wheat	11.6	2.9	12.5	4.9	65.1	3.0
Serradella, green	79.5	3.2	2.7	5.4	8.6	0.7
Serradella hay	9.2	7.2	15.2	21.6	44.2	2.6
Sesame oil cake	7.4	8.8	36.7	3.8	17.3	26.0
Shorts	11.2	4.4	16.9	6.2	56.2	5.1
Silage, apple pumace	85.0	0.6	1.2	3.3	8.8	1.1
Silage, barley	75.0	2.6	2.6	9.4	9.4	1.0
Silage, Barnyard millet and soybean	79.0	2.8	2.8	7.2	7.2	1.0
Silage, brewers' grains, wet	70.3	1.2	6.3	4.5	15.6	2.1
Silage, corn	73.6	2.1	2.7	7.8	12.9	0.9
Silage, corn, soybeans	76.0	2.4	2.5	7.2	11.1	0.8
Silage, corn cobs, cannery refuse	74.1	0.5	1.5	7.9	14.3	1.7
Silage, corn, ears removed	73.7	1.6	2.2	6.5	15.1	0.9
Silage, corn husks, cannery refuse	83.8	0.6	1.4	5.2	7.9	1.1
Silage, corn immature	79.1	1.4	1.7	6.0	11.0	0.8
Silage, cowpea	79.3	2.9	2.7	6.0	7.6	1.5
Silage, cowpea and soybean	69.8	4.5	3.8	9.5	11.1	1.3

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Silage, Durra-maize...	79.7	1.8	1.2	7.0	9.5	0.7
Silage, field peas.....	50.1	3.5	5.9	13.0	26.0	1.6
Silage, Kafir-corn.....	67.2	2.9	2.1	11.2	15.2	1.4
Silage, millet.....	74.0	2.4	1.7	7.5	13.6	0.8
Silage, Milo-maize	74.6	1.8	2.2	7.9	12.7	0.7
Silage, peas, cannery refuse.....	76.8	1.3	2.8	6.5	11.3	1.3
Silage, Red clover.....	72.0	2.6	4.2	8.4	11.6	1.2
Silage, rye.....	80.8	1.6	2.4	5.8	9.2	0.3
Silage, sorghum.....	76.1	1.1	0.8	6.4	15.3	0.3
Silage, soybean.....	74.2	2.8	4.1	9.7	6.9	2.2
Silage, soybean and Barnyard millet.....	79.0	2.8	2.8	7.2	7.2	1.0
Silage, sugar-beet pulp	90.0	0.3	1.5	3.1	4.7	0.4
Silage, teosinte.....	66.8	4.0	2.5	12.3	13.6	0.8
Sorghum bagasse	11.4	2.9	3.4	30.5	50.4	1.4
Sorghum forage.....	41.7	3.0	3.2	17.0	32.0	2.9
Sorghum, green.....	79.4	1.1	1.3	6.1	11.6	0.5
Sorghum seed.....	12.8	2.1	9.1	2.6	69.8	3.6
Soybean cake.....	11.3	5.9	42.7	6.0	28.1	6.0
Soybean hay.....	11.8	7.0	14.9	24.2	37.8	4.3
Soybean seeds.....	11.7	4.8	33.5	4.5	28.3	17.2
Soybean straw.....	10.1	5.8	4.6	40.4	37.4	1.7
Soybean vines, green..	75.1	2.6	4.0	6.7	10.6	1.0
Spelt, grain.....	8.0	3.9	11.5	11.1	62.9	2.2
Spelt hay.....	6.9	11.1	10.7	34.1	35.8	1.4
Spring vetch, green....	85.0	1.4	2.7	4.5	6.1	0.4
Spurry.....	75.7	4.0	2.0	4.9	12.7	0.8
Standard wheat middlings.....	11.2	4.4	16.9	6.2	56.2	5.1
Starch feed, wet.....	68.8	0.4	5.0	2.9	19.9	3.0
Starch refuse.....	12.0	1.8	4.8	3.8	76.3	1.3
Sugar beets.....	86.5	0.9	1.8	0.9	9.8	0.1
Sugar-beet leaves.....	88.0	2.4	2.6	2.2	4.4	0.4
Sugar cane, green.....	84.2	1.1	1.2	4.0	9.0	0.5
Sunflower seed.....	8.6	2.6	16.3	29.9	21.4	21.2
Sunflower-seed cake...	10.8	6.7	32.8	13.5	27.1	9.1

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Sunflower-seed kernels	6.9	2.8	30.5	2.6	14.5	42.8
Swamp-grass hay	11.6	6.7	7.2	26.6	45.9	2.0
Sweet clover, green	80.0	1.9	3.8	6.3	7.4	0.6
Sweet-clover hay	9.1	8.9	16.2	25.2	37.7	2.9
Sweet potatoes	68.3	1.1	1.9	1.1	26.8	0.7
Tall oat-grass hay	14.0	4.6	6.4	30.9	42.1	1.9
Tall oat grass, in bloom	69.5	2.0	2.4	9.4	15.8	0.9
Tankage	7.0	15.9	53.9	5.8	5.6	11.8
Teosinte, green	90.1	1.4	1.4	2.7	4.1	0.3
Texas blue-grass hay	14.3	10.0	9.1	27.3	36.1	3.2
Timothy, different stages, green	61.6	2.1	3.1	11.8	20.2	1.2
Timothy hay, all analyses	13.2	4.4	5.9	29.0	45.0	2.5
Timothy hay, cut after bloom	14.2	4.4	5.7	28.1	44.6	3.0
Timothy hay, cut in full bloom	15.0	4.5	6.0	29.6	41.9	3.0
Timothy hay, cut nearly ripe	14.1	3.9	5.0	31.1	43.7	2.2
Turnips	90.1	0.9	1.3	1.2	6.3	0.2
Velvet bean, green	82.2	1.9	3.5	5.1	6.6	0.7
Velvet-bean hay	10.0	5.9	14.0	37.7	30.6	1.8
Vetch and barley, green	80.0	1.2	2.8	6.5	9.0	0.5
Vetch and oat hay	15.0	7.4	12.8	26.7	35.8	2.3
Vetch and oats, green	80.0	1.8	3.0	6.3	8.4	0.5
Vetch and wheat, green	80.0	1.6	3.4	6.4	8.1	0.5
Vetch and wheat hay	15.0	6.8	14.5	27.2	34.4	2.1
Vetch hay	11.3	7.9	17.0	25.4	36.1	2.3
Vetch, Sand, green	85.3	2.1	3.6	4.0	4.6	0.4
Vetch, Spring, green	85.0	1.4	2.7	4.5	6.1	0.4
Wheat and vetch, green	80.0	1.6	3.4	6.4	8.1	0.5
Wheat and vetch hay	15.0	6.8	14.5	27.2	34.4	2.1
Wheat bran, all analyses	11.9	5.8	15.4	9.0	53.9	4.0
Wheat chaff	14.3	9.2	4.5	36.0	34.6	1.4

TABLE II—(*Continued*)

Feedstuff	Composition					
				Carbohydrates		
	Water Per Cent.	Ash Per Cent.	Protein Per Cent.	Fiber Per Cent.	Nitrogen-Free Extract Per Cent.	Fat Per Cent.
Wheat feed, shorts and bran	10.9	5.6	16.3	7.5	55.1	4.6
Wheat flour	12.4	0.4	12.0		74.0	1.2
Wheat-flour middlings	10.0	3.2	19.2	3.2	59.6	4.8
Wheat fodder, green	77.3	1.8	2.4	5.9	11.9	0.7
Wheat grain, all analyses	10.5	1.8	11.9	1.8	71.9	2.1
Wheat screenings	11.6	2.9	12.5	4.9	65.1	3.0
Wheat, spring, grain	10.4	1.9	12.5	1.8	71.2	2.2
Wheat straw	9.6	4.2	3.4	38.1	43.4	1.3
Wheat, winter, grain	10.5	1.8	11.8	1.8	72.0	2.1
Whey	93.8	0.4	0.6		5.1	0.1
White-clover hay	9.7	8.3	15.7	24.1	39.3	2.9
White-daisy hay	10.3	6.6	7.7	30.0	42.0	3.4
White Kafir corn, green	83.4	1.4	1.9	4.6	8.0	0.7
White-top hay	14.0	6.0	11.2	24.4	41.5	2.9
Wild-oat hay	14.1	3.8	5.0	25.0	48.8	3.3
Yellow Milo maize, green	83.2	1.5	1.7	5.5	7.5	0.6

TABLE III

TOTAL DRY MATTER AND TOTAL DIGESTIBLE NUTRIENTS IN 100 POUNDS OF AMERICAN FEEDSTUFFS

Feedstuff	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein Pounds	Carbohydrates Pounds	Fat Pounds
Acorns	44.7	2.1	34.4	1.7
Alfalfa, green	28.2	3.6	12.1	0.4
Alfalfa hay	93.4	11.4	40.0	1.3
Alfalmo	90.9	9.8	40.8	0.9
Alsike clover, green	25.2	2.6	11.4	0.5
Alsike-clover hay	90.3	8.4	39.7	1.1
Apple pomace	17.0	0.6	13.1	0.5
Apples	22.2	0.8	16.5	0.2
Artichokes	20.5	1.3	14.7	0.2
Australian salt bush	22.0	2.0	8.5	0.3
Australian salt-bush hay	90.8	3.8	28.8	0.7
Bagasse, sorghum	88.6	0.5	52.2	0.7
Bakery refuse	87.0	7.0	55.5	4.8
Banana butts, dry	86.5	2.1	37.1	0.9
Banana tops, dry	93.6	4.4	36.6	0.8
Barley and peas, green	20.0	2.1	9.1	0.4
Barley and vetch, green	20.0	2.1	6.5	0.3
Barley feed	91.1	11.5	60.3	2.9
Barley forage	21.0	1.9	10.4	0.3
Barley, grain	89.2	8.4	65.3	1.6
Barley hay	85.0	5.7	43.6	1.0
Barley screenings	87.8	9.5	49.9	2.5
Barley straw	85.8	0.9	40.1	0.6
Barnyard millet, green	25.0	1.6	14.4	0.3
Barnyard millet hay	85.1	5.2	38.6	0.8
Bean, horse, green	15.8	2.3	7.3	0.2
Bean, horse, hay	90.8	4.3	39.5	0.8
Bean, table, meal	89.1	20.2	42.3	1.3
Bean, velvet, green	17.8	2.7	8.4	0.4
Bean, velvet, hay	90.0	9.6	52.5	1.4
Beans, horse	88.7	23.1	49.8	0.8
Beech twigs, dry, gathered in winter	84.7	0.9	21.8	0.6
Beet leaves, sugar-	12.0	1.9	5.0	0.2
Beet pulp, dry	91.6	4.1	64.9	
Beet pulp, wet	10.2	0.5	7.7	
Beets, common	11.5	1.2	7.9	0.1
Beets, sugar	13.5	1.3	9.8	0.1

TABLE III—(*Continued*)

Feedstuff	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein Pounds	Carbohydrates Pounds	Fat Pounds
Beggar-weed hay	90.8	6.8	42.8	1.6
Bermuda grass, green	28.3	1.3	13.4	0.4
Bermuda-grass hay	93.1	6.4	44.9	1.6
Blood, dried	91.5	60.8		2.5
Bone-and-meat meal	94.0	36.7	5.5	10.6
Bran, corn	90.6	6.0	52.5	4.8
Bran, wheat, all analyses	88.1	11.9	42.0	2.5
Bran, wheat, spring	88.0	11.9	43.1	3.1
Bran, wheat, winter	88.5	12.1	37.1	2.6
Brewers' grains, dry	91.3	20.0	32.2	6.0
Brewers' grains, wet	23.0	4.9	7.6	1.7
Broom-corn seed	87.2	4.6	42.2	1.5
Buckwheat bran	91.8	5.9	34.0	2.0
Buckwheat feed	88.4	15.6	38.2	4.4
Buckwheat flour	85.4	5.9	63.0	1.2
Buckwheat, grain	86.6	8.1	48.2	2.4
Buckwheat hulls	86.8	1.2	28.6	0.5
Buckwheat middlings	87.2	22.7	37.5	6.1
Buckwheat straw	90.1	1.2	37.4	0.5
Buffalo-grass hay	85.0	3.0	42.0	1.6
Bur-clover hay	91.0	8.2	39.0	2.1
Buttercup hay	90.7	4.8	40.7	1.8
Buttermilk	9.9	3.8	3.9	1.0
Cabbage	10.0	2.3	5.9	0.1
Cacti, cane	21.5	0.9	11.1	0.4
Canada field peas	85.0	19.7	49.3	0.4
Canada field-pea bran	89.0	7.7	41.6	0.6
Canada field peas, green	15.3	1.8	6.9	0.3
Canada field peas, in bloom	13.0	2.3	5.3	0.2
Canada field peas, in bud	15.0	2.6	6.8	0.3
Canada field peas, in pod	16.0	1.9	7.0	0.2
Canada field-pea meal	89.5	16.8	51.7	0.7
Carrots	11.4	0.8	7.7	0.3
Cassava	34.0	0.8	28.9	0.2
Cassava starch refuse	88.0	0.4	74.0	0.6
Cattail-millet hay	89.0	7.2	41.6	1.0
Chop, hominy	90.4	6.8	60.5	7.4
Chufa	20.5	0.6	9.1	5.6

TABLE III—(*Continued*)

Feedstuff	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein Pounds	Carbohydrates Pounds	Fat Pounds
Clover and grass, green, mixed	25.0	2.3	14.6	0.5
Clover and grass, mixed, hay	87.1	5.8	41.8	1.3
Cocoanut cake	89.7	15.4	41.2	10.7
Colostrum	25.4	17.6	2.7	3.6
Comfrey, prickly	13.0	1.7	5.1	0.2
Common beets	11.5	1.2	7.9	0.1
Common Little sage	65.0	3.2	19.7	0.9
Common millet, green	20.0	0.8	11.0	0.2
Common sage	50.4	1.2	14.1	3.8
Corn-and-cob meal	84.9	4.4	60.0	2.9
Corn bran	90.6	6.0	52.5	4.8
Corn cob	89.3	0.5	44.8	
Corn, dent, grain	89.4	7.8	66.8	4.3
Corn, flint, grain	88.7	8.0	66.2	4.3
Corn fodder, ears on	57.8	2.5	34.6	1.2
Corn fodder, flint varieties, kernels glazed	22.9	1.1	25.0	0.7
Corn fodder, green, all varieties	20.7	1.0	11.9	0.4
Corn fodder, green, dent varieties	21.0	20.9	12.2	0.4
Corn fodder, green, flint varieties	20.2	1.1	11.4	0.5
Corn fodder, green, kernels glazed	26.6	1.1	15.0	0.7
Corn fodder, sweet varieties, green	20.9	1.2	12.6	0.4
Corn fodder, sweet, without ears, green	20.0	0.7	11.6	0.4
Corn husks	49.1	0.8	33.8	0.2
Corn leaves	70.0	2.8	37.8	0.8
Corn meal	85.0	6.7	64.3	3.5
Corn stover, ears removed	59.5	1.4	31.2	0.7
Corn, sweet, grain	91.2	8.8	63.7	7.0
Cottonseed	89.7	12.5	30.0	17.3
Cottonseed hulls	88.9	0.3	33.2	1.7
Cottonseed meal	93.0	37.6	21.4	9.6

TABLE III—(*Continued*)

Feedstuff	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein Pounds	Carbohydrates Pounds	Fat Pounds
Cottonseed, roasted	93.9	7.9	25.5	19.9
Cowpeas, green	16.4	1.8	8.7	0.2
Cowpea hay	89.5	5.8	9.3	1.3
Cowpea seeds	85.4	16.8	54.9	1.1
Crimson clover, green	19.1	2.4	9.1	0.5
Crimson-clover hay	90.4	10.5	34.9	1.2
Dandelions	15.7	1.1	7.5	2.0
Distillers' grains, dry	92.4	22.8	39.7	11.6
Dried blood	91.5	60.8		2.5
Dried fish	89.2	45.0		11.4
Dwarf Essex rape	14.3	2.0	8.2	0.2
Dwarf Essex rape, summer, Southern States	15.0	1.9	8.6	0.2
Dwarf Essex rape, winter, Southern States	15.0	2.0	8.1	0.2
Emmer, grain	91.6	10.0	70.3	2.0
Emmer hay	93.1	7.0	43.9	0.6
English hay	86.0	4.5	44.0	1.2
Field-bean hay	95.0	3.6	39.7	
Field-pea bran, Canada	89.0	7.7	41.6	0.6
Field-pea seeds, Canada	85.0	19.7	49.3	0.4
Field peas, Canada, green	15.3	1.8	6.9	0.3
Field peas, Canada, in bloom	13.0	2.3	5.3	0.2
Field peas, Canada, in bud	15.0	2.6	6.8	0.3
Field peas, Canada, in pod	16.0	1.9	7.0	0.2
Field-pea meal, Canada	89.5	16.8	51.7	0.7
Fish, dried	89.2	45.0		11.4
Flat turnips	9.9	0.9	6.4	0.1
Flaxseed	90.8	20.6	17.1	29.0
Flax shives	90.0	1.2	34.4	1.0
Flour, buckwheat	85.4	5.9	63.0	1.2
Flour, high-grade, wheat	87.6	10.6	65.1	1.0
Flour, red-dog	90.1	16.2	57.0	3.4
Flour, rye	86.9	5.6	72.2	0.5
Flour, wheat, middlings	90.0	16.9	53.6	4.1
Fodder corn, ears on	57.8	2.5	34.6	1.2
Gama-grass hay	85.7	4.2	39.9	0.9
Germ oil meal	91.4	15.8	38.8	10.8
Gluten feed	90.8	21.3	52.8	2.9

TABLE III—(*Continued*)

Feedstuff	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein Pounds	Carbohydrates Pounds	Fat Pounds
Grass and clover, mixed, green	25.0	2.3	14.6	0.5
Grass and clover, mixed, hay	87.1	5.8	41.8	1.3
Greasewood	95.4	10.9	40.9	1.8
Guinea-grass hay	92.4	3.3	47.2	0.5
Hairy vetch, in bloom	18.0	3.5	7.7	0.3
Hairy vetch, winter	15.0	2.8	6.4	0.3
Hairy vetch, winter, hay	88.7	11.9	40.7	1.6
Hay from mixed grasses	84.7	4.2	42.0	1.3
Hog millet, green	20.0	0.8	10.8	0.3
Hominy feed	90.4	6.8	60.5	7.4
Horse bean, green	15.8	2.3	7.3	0.2
Horse-bean hay	90.8	4.3	39.5	0.8
Horse beans	88.7	23.1	49.8	0.8
Hungarian grass, green	28.9	2.0	15.9	0.4
Hungarian-grass hay	86.0	5.0	46.9	1.1
Hungarian-grass seed	90.5	6.4	48.8	3.3
Italian rye grass	27.0	1.5	12.6	0.7
Italian rye-grass hay	91.5	4.5	43.4	0.9
Japan-clover hay	89.0	9.1	37.7	1.4
Japanese millet, green	25.0	1.1	13.6	0.3
Johnson grass, green	25.0	0.6	13.7	0.2
Johnson-grass hay	89.8	2.9	45.6	0.8
Kafir corn, grain	90.1	5.2	44.3	1.4
Kafir corn, heads, ground	86.4	4.2	42.4	1.2
Kafir corn, Red, green	18.4	0.8	9.7	0.4
Kafir corn, White, green	16.6	0.9	8.3	0.5
Kentucky blue grass	34.9	2.8	19.7	0.8
Kentucky blue-grass hay	86.0	4.4	40.2	0.7
Linseed meal, new-process	90.3	31.5	35.7	2.4
Linseed meal, old-process	90.2	30.2	32.0	6.9
Macaroni-wheat hay	93.0	4.4	48.7	0.8
Malt sprouts	90.5	20.3	46.0	1.4
Mammoth clover, green	20.0	2.0	9.1	0.2
Mammoth-clover hay	78.8	6.2	34.7	2.1
Mangels	9.1	1.0	5.5	0.2
Meadow fescue, green	30.1	1.6	18.6	0.5
Meadow-fescue hay	80.8	4.2	36.9	1.5
Meadow-foxtail hay	93.4	5.3	41.0	1.3

TABLE III—(*Continued*)

Feedstuff	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein Pounds	Carbohydrates Pounds	Fat Pounds
Meat-and-bone meal	94.0	36.7	5.5	10.6
Meat scrap	89.3	66.2		13.4
Middlings, buckwheat	87.2	22.7	37.5	6.1
Middlings, flour, wheat	90.0	16.9	53.6	4.1
Middlings, oat	91.2	13.1	57.7	6.5
Middlings, rye	88.2	11.0	52.9	2.6
Middlings, wheat, standard	88.8	13.0	45.7	4.5
Milk, cow's	12.8	3.4	4.8	3.7
Milk, skim	9.4	2.9	5.3	0.3
Millet, Barnyard, green;	25.0	1.6	14.4	0.3
Millet, Barnyard, hay	85.1	5.2	38.6	0.8
Millet, Common	20.0	0.8	11.0	0.2
Millet, Hog	20.0	0.8	10.8	0.3
Millet, Japanese, green	25.0	1.1	13.6	0.3
Millet, Pearl	18.5	0.6	10.0	0.2
Millet seed	87.9	7.1	48.5	2.5
Millet straw	85.0	0.9	34.3	0.6
Milo maize, heads, ground	90.3	4.2	45.0	1.1
Milo maize, seed	91.0	4.9	44.8	1.3
Milo maize, Yellow, green	16.8	1.1	9.3	0.3
Mixed grass and clover, green	25.0	2.3	14.6	0.5
Mixed grass and clover hay	87.1	5.8	41.8	1.3
Molasses, beet, pulp, dry	92.0	6.1	68.7	
Molasses grains	89.6	10.8	48.0	2.2
Molasses, Porto Rico	74.1	1.4	59.2	
Molasses, sugar-beet	79.2	4.7	54.1	
New corn product	91.2	3.5	39.7	1.6
Oak leaves, dry, gathered in July	94.6	3.2	34.6	1.6
Oat and pea hay	89.5	7.6	41.5	1.5
Oat and vetch hay	85.0	8.3	35.8	1.3
Oat chaff	85.7	1.5	33.0	0.7
Oat dust	93.5	5.1	32.8	2.3
Oat feed	93.0	5.2	30.1	2.6
Oat forage, in bloom	25.0	1.1	12.4	0.5
Oat forage, in milk	37.8	2.5	18.2	1.0
Oat grass, tall, green	30.5	1.2	15.7	0.5
Oat hay	86.0	4.7	36.7	1.7

TABLE III—(*Continued*)

Feedstuff	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein Pounds	Carbohydrates Pounds	Fat Pounds
Oat hulls	92.6	1.3	38.5	0.6
Oat meal	92.1	11.9	65.1	6.7
Oat middlings	91.2	13.1	57.7	6.5
Oat straw	90.8	1.3	39.5	0.8
Oats and peas, green	20.3	1.8	10.2	0.4
Oats and vetch, green	20.0	2.3	10.0	0.2
Oats, grain	89.6	10.7	50.3	3.8
Oats, ground	88.0	10.1	52.5	3.7
Orchard grass	27.0	1.2	13.4	0.5
Orchard-grass hay	90.1	4.9	42.4	1.4
Oxeye-daisy hay	89.7	3.7	41.0	1.7
Palmnut cake	89.6	16.0	52.6	9.0
Para-grass hay	92.4	5.5	45.6	0.6
Parsnips	9.5	1.0	7.2	0.2
Pasture grass	20.0	2.5	10.1	0.5
Pea and oat hay	89.5	7.6	41.5	1.5
Peanut cake	89.3	42.8	20.4	7.2
Peanut kernels, without hulls	92.5	25.1	13.7	35.6
Peanut-vine hay	92.4	6.7	42.2	3.0
Peas and barley, green	20.0	2.1	9.1	0.4
Peas and oats, green	20.3	1.8	10.2	0.4
Pearl millet, green	18.5	0.6	10.0	0.2
Perennial rye-grass hay	86.0	6.1	37.8	1.2
Potato	20.9	1.1	15.7	0.1
Potato pomace	8.5	0.4	6.8	0.1
Prairie hay	90.8	3.0	42.9	1.6
Prickly comfrey	13.0	1.7	5.1	0.2
Prickly pear	15.8	0.4	6.2	0.2
Pumpkin, field	9.1	1.0	5.8	0.2
Pumpkin, garden	13.2	1.4	8.3	0.4
Purslane	9.0	2.0	4.5	0.1
Rape-seed cake	90.0	25.3	23.7	7.6
Red clover, green	29.2	2.9	14.9	0.7
Red-clover hay	84.7	7.1	37.8	1.8
Red-clover hay, cut in bloom	79.2	7.7	34.0	2.8
Red-dog flour	90.1	16.2	57.0	3.4
Red Kafir corn, green	18.4	0.8	9.7	0.4
Red-top grass, in bloom	34.7	1.9	21.3	0.5

TABLE III—(*Continued*)

Feedstuff	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein Pounds	Carbohydrates Pounds	Fat Pounds
Red-top hay	91.1	4.8	46.9	1.0
Rice bran	90.3	7.6	38.8	7.3
Rice, grain	87.6	6.4	79.2	0.4
Rice hulls	91.2	0.3	19.9	0.1
Rice meal	89.8	7.4	48.3	11.9
Rice polish	89.5	7.9	58.6	5.3
Rowen hay	86.0	7.9	42.2	1.4
Rowen, mixed, hay	83.4	8.0	40.1	1.5
Rutabagas	11.4	1.0	8.1	0.2
Rye bran	88.2	11.2	46.8	1.8
Rye feed	87.6	12.6	56.6	2.8
Rye flour	86.9	5.6	72.2	0.5
Rye forage	23.4	2.1	14.1	0.4
Rye, grain	91.3	9.5	69.4	1.2
Rye-grass hay, Perennial	86.0	6.1	37.8	1.2
Rye-grass hay, Italian	91.5	4.5	43.4	0.9
Rye middlings	88.2	11.0	52.9	2.6
Rye straw	92.9	0.7	39.6	0.4
Sage, Common	50.4	1.2	14.1	3.8
Sage, Little, Common	65.0	3.2	19.7	0.9
Salt bush, Australian	22.0	2.0	8.5	0.3
Salt bush hay, Australian	90.8	3.8	28.8	0.7
Salt-marsh-grass hay	89.6	3.1	39.7	0.9
Sanfoin, green	25.0	2.9	11.1	0.5
Sanfoin hay	85.0	10.4	36.5	2.0
Screenings, barley	87.8	9.5	49.9	2.5
Screenings, wheat	88.4	9.6	48.2	1.9
Serradella, green	20.5	2.1	8.9	0.4
Serradella hay	90.8	11.4	38.6	1.7
Sesame oil cake	92.6	33.0	10.9	23.4
Shorts	88.8	13.0	45.7	4.5
Silage, apple-pomace	15.0	0.7	9.6	0.5
Silage, Barnyard millet and soybean	21.0	1.6	9.2	0.7
Silage, brewers' grains	29.7	4.6	11.5	1.8
Silage, Canada field-pea	49.9	3.4	25.5	1.0
Silage, corn	26.4	1.4	14.2	0.7
Silage, corn and soybean	24.0	1.6	13.2	0.7
Silage, corn cobs, cannery refuse	25.9	0.3	13.7	0.9

TABLE III—(*Continued*)

Feedstuff	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein Pounds	Carbohydrates Pounds	Fat Pounds
Silage, corn, ears removed	26.3	1.1	14.9	0.7
Silage, corn husks, cannery refuse	16.2	0.4	10.1	0.4
Silage, cowpea and soybean	30.2	2.2	12.9	0.8
Silage, cowpea-vine	20.7	1.5	8.6	0.9
Silage, field-pea, Canada	49.9	3.4	25.5	1.0
Silage, millet	26.0	0.2	13.1	0.6
Silage, pea, cannery refuse	23.2	2.1	13.1	0.8
Silage, rye	19.2	0.7	9.0	0.2
Silage, Red clover	28.0	1.5	9.2	0.5
Silage, sorghum	23.9	0.1	13.5	0.2
Silage, soybean	25.8	2.7	9.6	1.3
Sorghum bagasse	88.6	0.5	52.2	0.7
Sorghum fodder, green	20.6	0.6	11.6	0.3
Sorghum seed	87.2	4.5	61.1	2.8
Soybean, green	24.9	3.1	11.0	0.5
Soybean hay	88.2	10.6	40.9	1.2
Soybean seeds	88.3	29.1	23.3	14.6
Soybean straw	89.9	2.3	40.1	1.0
Spelt, grain	92.0	10.0	70.3	2.0
Spelt, hay	93.1	7.0	43.9	0.6
Spring vetch, green	15.0	1.9	6.6	0.2
Spurry	20.0	1.5	9.8	0.3
Standard wheat middlings	88.8	13.0	45.7	4.5
Starch feed, wet	31.2	3.7	12.4	2.6
Starch refuse	88.0	2.4	70.6	1.1
Starch refuse, cassava	88.0	0.4	74.0	0.6
Sugar beets	13.5	1.3	9.8	0.1
Sugar-beet leaves	12.0	1.9	5.0	0.2
Sugar-beet molasses	79.2	4.7	54.1	
Sugar cane, green	15.8	0.5	9.5	0.3
Sunflower seed	91.4	14.8	29.7	18.2
Sunflower-seed cake	89.2	29.5	23.3	8.0
Swamp-grass hay	88.4	4.0	38.9	0.7
Sweet clover, green	20.0	2.5	8.4	0.4
Sweet-clover hay	90.9	11.9	36.7	0.5
Sweet corn, grain	91.2	8.8	63.7	7.0
Sweet potatoes	28.9	0.8	22.9	0.3
Table-bean meal	89.1	20.2	42.3	1.3

TABLE III—(*Continued*)

Feedstuff	Total Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein Pounds	Carbohydrates Pounds	Fat Pounds
Tall-oat hay	86.0	3.3	41.4	1.1
Tankage	93.0	50.1		11.6
Teosinte, green	9.9	0.9	4.9	0.2
Texas blue-grass hay	85.7	5.1	36.3	1.4
Timothy grass	38.4	1.5	19.9	0.6
Timothy hay, all analyses	86.8	2.8	42.4	1.3
Timothy hay, cut after bloom	85.8	2.5	39.2	1.5
Timothy hay, cut in full bloom	85.0	3.4	43.3	1.4
Timothy hay, cut nearly ripe	85.9	2.1	40.1	1.1
Tree leaves, dry, gathered in July	84.0	3.5	30.4	1.1
Turnips, flat	9.9	0.9	6.4	0.1
Velvet bean, green	17.8	2.7	8.4	0.4
Velvet-bean hay	90.0	9.6	52.5	1.4
Vetch and barley, green	20.0	2.1	6.5	0.3
Vetch and oat hay	85.0	8.3	35.8	1.3
Vetch and oats, green	20.0	2.3	10.0	0.2
Vetch and wheat, green	20.0	2.6	10.3	0.3
Vetch and wheat, hay	85.0	10.6	36.8	1.2
Vetch, green	15.0	1.9	6.6	0.2
Vetch, Hairy, in bloom	18.0	3.5	7.7	0.3
Vetch, Hairy, winter, green	15.0	2.8	6.4	0.3
Wheat and vetch, green	20.0	2.6	10.3	0.3
Wheat and vetch hay	85.0	10.6	36.8	1.2
Wheat bran, all analyses	88.1	11.9	42.0	2.5
Wheat chaff	85.7	1.2	25.4	0.6
Wheat feed	89.1	12.7	47.1	4.0
Wheat flour, high-grade	87.6	10.6	65.1	1.0
Wheat forage	22.7	1.7	12.0	0.4
Wheat, grain	89.5	8.8	67.5	1.5
Wheat screenings	88.4	9.6	48.2	1.9
Wheat straw	90.4	0.8	35.2	0.4
Whey	6.2	0.6	5.0	0.2
White-clover hay	90.3	11.5	42 2	1.5
White Kafir corn, green	16.6	0.9	8.3	0.5
White-top hay	86.0	6.8	40.6	1.5
Wild-oat grass	85.9	2.9	48.7	1.7

TABLE IV

WOLFF-LEHMANN FEEDING STANDARDS

Animal	Requirements per Day per 1,000 Pounds Live Weight				
	Dry Matter Pounds	Digestible Nutrients			
		Crude Protein Pounds	Carbohydrates Pounds	Fat Pounds	Nutritive Ratio
Oxen:					
At rest in stall	18	0.7	8.0	0.1	1 to 11.8
At light work	22	1.4	10.0	0.3	1 to 7.6
At medium work	25	2.0	11.5	0.5	1 to 6.3
At heavy work	28	2.8	13.0	0.8	1 to 5.3
Fattening cattle:					
First period	30	2.5	15.0	0.5	1 to 6.5
Second period	30	3.0	14.5	0.7	1 to 5.4
Third period	26	2.7	15.0	0.7	1 to 6.1
Milk cows when yielding daily:					
11.0 pounds of milk	25	1.6	10.0	0.3	1 to 6.7
16.6 pounds of milk	27	2.0	11.0	0.4	1 to 6.0
22.0 pounds of milk	29	2.5	13.0	0.5	1 to 5.7
27.5 pounds of milk	32	3.3	13.0	0.8	1 to 4.5
Sheep:					
Coarse-wool	20	1.2	10.5	0.2	1 to 9.1
Fine-wool	23	1.5	12.0	0.3	1 to 8.5
Breeding ewes with lambs	25	2.9	15.0	0.5	1 to 5.6
Fattening sheep:					
First period	30	3.0	15.0	0.5	1 to 5.4
Second period	28	3.5	14.5	0.6	1 to 4.2
Horses:					
At light work	20	1.5	9.5	0.4	1 to 6.9
At medium work	24	2.0	11.0	0.6	1 to 6.2
At heavy work	26	2.5	13.3	0.8	1 to 6.0
Brood sows	22	2.5	15.5	0.4	1 to 6.6
Fattening swine:					
First period	36	4.5	25.0	0.7	1 to 5.9
Second period	32	4.0	24.0	0.5	1 to 6.3
Third period	25	2.7	18.0	0.4	1 to 7.0
Growing cattle—Dairy breeds:					
Age, 2 to 3 months; average live weight, 150 pounds	23	4.0	13.0	2.0	1 to 4.4

TABLE IV—(*Continued*)

Animal	Requirements per Day per 1,000 Pounds Live Weight				
	Dry Matter Pounds	Digestible Nutrients			
		Crude Protein Pounds	Carbohydrates Pounds	Fat Pounds	Nutritive Ratio
Growing cattle—Dairy breeds: Continued:					
Age, 3 to 6 months; average live weight, 300 pounds	24	3.0	12.8	1.0	1 to 5.0
Age, 6 to 12 months; average live weight, 500 pounds	27	2.0	12.5	0.5	1 to 6.8
Age, 12 to 18 months; average live weight, 700 pounds	26	1.8	12.5	0.4	1 to 7.4
Age, 18 to 24 months; average live weight, 900 pounds	26	1.5	12.0	0.3	1 to 8.5
Growing cattle—Beef breeds:					
Age, 2 to 3 months; average live weight, 160 pounds	23	4.2	13.0	2.0	1 to 4.2
Age, 3 to 6 months; average live weight, 330 pounds	24	3.5	12.8	1.5	1 to 4.6
Age, 6 to 12 months; average live weight, 550 pounds	25	2.5	13.2	0.7	1 to 5.9
Age, 12 to 18 months; average live weight, 750 pounds	24	2.0	12.5	0.5	1 to 6.8
Age, 18 to 24 months; average live weight, 950 pounds	24	1.8	12.0	0.4	1 to 7.2
Growing sheep—Wool breeds:					
Age, 4 to 6 months; average live weight, 60 pounds	25	3.4	15.4	0.7	1 to 5.0
Age, 6 to 8 months; average live weight, 75 pounds	25	2.8	13.8	0.6	1 to 5.4

TABLE IV—(*Continued*)

Animal	Requirements per Day per 1,000 Pounds Live Weight				
	Dry Matter Pounds	Digestible Nutrients			
		Crude Protein Pounds	Carbohydrates Pounds	Fat Pounds	Nutritive Ratio
Growing sheep—Wool breeds: Continued:					
Age, 8 to 11 months; average live weight, 80 pounds	23	2.1	11.5	0.5	1 to 6.0
Age, 11 to 15 months; average live weight, 90 pounds	22	1.8	11.2	0.4	1 to 6.7
Age, 15 to 20 months; average live weight, 100 pounds	22	1.5	10.8	0.3	1 to 7.7
Growing sheep—Mutton breeds:					
Age, 4 to 6 months; average live weight, 60 pounds	26	4.4	15.5	0.9	1 to 4.0
Age, 6 to 8 months; average live weight, 80 pounds	26	3.5	15.0	0.7	1 to 4.7
Age, 8 to 11 months; average live weight, 100 pounds	24	3.0	14.3	0.5	1 to 5.1
Age, 11 to 15 months; average live weight, 120 pounds	23	2.2	12.6	0.5	1 to 6.2
Age, 15 to 20 months; average live weight, 150 pounds	22	2.0	12.0	0.4	1 to 6.5
Growing swine—breeding stock:					
Age, 2 to 3 months; average live weight, 50 pounds	44	7.6	28.0	1.0	1 to 4.0
Age, 3 to 5 months; average live weight, 100 pounds	35	4.8	22.5	0.7	1 to 5.0
Age, 5 to 6 months; average live weight, 120 pounds	32	3.7	21.3	0.4	1 to 6.0

TABLE IV—(*Continued*)

Animal	Requirements per Day per 1,000 Pounds Live Weight				
	Dry Matter Pounds	Digestible Nutrients			
		Crude Protein Pounds	Carbohydrates Pounds	Fat Pounds	Nutritive Ratio
Growing swine—breeding stock: continued:					
Age, 6 to 8 months; average live weight, 200 pounds	28	2.8	18.7	0.3	1 to 6.9
Age, 8 to 12 months; average live weight, 250 pounds	25	2.1	15.3	0.2	1 to 7.5
Growing fattening swine:					
Age, 2 to 3 months; average live weight, 50 pounds	44	7.6	28.0	1.0	1 to 4.0
Age, 3 to 5 months; average live weight, 100 pounds	35	5.0	23.1	0.8	1 to 5.0
Age, 5 to 6 months; average live weight, 150 pounds	33	4.3	22.3	0.6	1 to 5.5
Age, 6 to 8 months; average live weight, 200 pounds	30	3.6	20.5	0.4	1 to 5.9
Age, 9 to 12 months; average live weight, 300 pounds	26	3.0	18.3	0.3	1 to 6.3

PRINCIPLES OF ANIMAL BREEDING

INTRODUCTION

1. Animal breeding deals with an operation by which it is sought to render domestic animals more useful to man. The horse breeder endeavors to produce an animal that will surpass others in some desirable quality. Breeders of cattle, sheep, swine, and other domestic animals work with a similar aim in their respective groups. From observation and experience, certain principles that are of assistance in producing desired results have been deduced, and a discussion of the more important of these is given in the following pages. In the science of animal breeding, however, there are many unsolved problems and numerous questions that cannot be answered definitely at the present time. The breeder of domestic animals will find that a knowledge of the known principles will be invaluable to him in his work, and scarcely less helpful will be the ability to recognize the uncertainties of his vocation. In addition to a discussion of the fundamental principles of breeding, attention is given, in the following pages, to a brief consideration of **reproduction,** that is, the process by which animals multiply, or increase.

2. The farm animals of the present time are descendants of certain wild forms that were taken by man from their natural environment at an early period in the history of the human race. This transfer from a natural existence to an existence controlled by man resulted from the fact that primitive man found that certain wild animals were capable

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ENTERED AT STATIONERS' HALL, LONDON

of serving him by doing work, supplying food, or in other ways. Animals that have been transferred from natural to artificial conditions, adapted to serve mankind, and bred for many generations under these conditions are known as **domestic animals.**

Numerous classes of animals have been domesticated, but only horses, asses, cattle, sheep, goats, and swine will be considered in this Section. The work that these animals did for primitive man was practically the same as that they are doing for man at the present time. For example, the horse and the ass were adopted on account of their efficiency as beasts of burden; the cow, for the same service and also for furnishing meat and milk; the sheep and goat, for meat, milk, and fiber for clothing; and the hog, for meat. During the time of domestication special races or strains, known as **breeds,** have been developed within each of the classes of domestic animals. Breeds are so numerous that no attempt will be made here to give a complete list, but Percheron, Clydesdale, and Belgian horses and Shorthorn, Hereford, and Jersey cattle may be mentioned as examples that are well known.

REPRODUCTION

DEFINITIONS AND TERMS

3. The process by which animals multiply, or increase, is known as **reproduction.** The term **breeding** is also used to designate this process as well as in the sense of improving domestic animals, as already defined. Reproduction is one of the most important functions of animal life, since it is by this means that species are perpetuated. The reproductive process is also of interest to the breeder from the fact that an understanding of it enables him to grasp and apply the principles of breeding.

These considerations are of sufficient importance to warrant a description of the reproductive process. It should be borne in mind, however, that reproduction, in the higher

animals, such as are considered in this Section, is an exceedingly complex process and one that has engaged the earnest study and investigation of some of the best scientists. It involves many steps and processes that are but little understood, and to undertake a detailed description of all these steps and processes would require much space and be of little, if any, benefit to the breeder. In the following discussion, therefore, nothing but a mere outline of the reproductive process is attempted.

4. Among domestic animals, the male parent is commonly referred to as the **sire** and the female parent as the **dam.** Grandsire and grandam, second sire and second dam, etc., are terms commonly used in breeding literature and scarcely require definition. Male and female breeding animals are distinguished by different names in the different classes of domestic animals. The male breeding animal of horses is known as a *stallion*, or *stud;* of asses, as a *jack;* of cattle, as a *bull;* of sheep, as a *ram;* of goats, as a *buck;* and of swine, as a *boar*. The names for breeding females in the same classes are, *mare*, *jenny*, *cow*, *ewe*, *nanny* or *doe*, and *sow*, respectively. *Filly*, *heifer*, and *gilt* are terms used by livestock men to designate a young mare, a young cow, and a young sow, respectively. A young pig of either sex is commonly called a *shoat*. No definite statement can be made as to the exact age at which a filly becomes a mare or a heifer becomes a cow, etc., for the terms are more or less loosely used.

5. The domestic animals considered in this Section belong to the division of the animal kingdom known as *mammals*, so called from the fact that the females suckle their young. Examples of animals in which the young are not nourished in this way are birds, reptiles, fishes, etc. Reproduction in mammals differs somewhat from reproduction among other groups, and it should be noted that the statements in the following discussion, except where otherwise specified, apply to the mammal group only.

GERM CELLS

6. The *cell* is the unit of all animal life. The very lowest forms of animals consist of a single cell. Next above these forms come those that are made up of a cluster of cells. In succeeding forms in the scale of animal life the arrangement of this cluster of cells becomes more and more complex, but it is always made up of a larger or smaller number of individual cells. Hence the statement that the cell is the unit of all animal life. Almost all animal cells are so small that they cannot be distinguished with the naked eye. In order to see the cells in animal tissue, it is necessary to make use of a microscope. A good idea of the manner in which cells enter into the formation of tissue may be obtained, however, by an examination of a specimen of tissue from the vegetable kingdom, in which the cell is also the unit. In the edible part of an orange, for example, the cells are so enormously enlarged that they are easily distinguishable with the unaided eye, and an individual cell can be separated from the tissue and examined. In a general way, the arrangement of cells in some animal tissues resembles the arrangement of cells in the edible part of the orange.

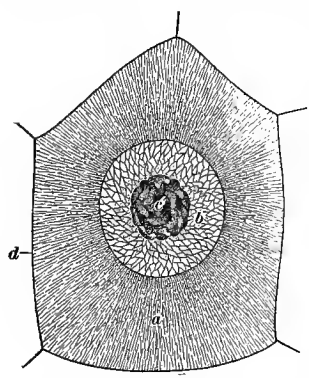


FIG. 1

7. A typical animal cell, highly magnified, is illustrated in Fig. 1. Its important parts are the *cell body a*, the *nucleus b*, the *nucleolus c*, and the *cell wall d*. These structures are characteristic and can usually be found in all cells, although the cell wall is sometimes absent. In the animal body there is considerable variety in the size and shape of cells in different parts of the body. Under the microscope, some will be found that resemble very closely the one shown in Fig. 1. Fat cells are usually globular; bone cells, very

irregular in outline; muscle cells, spindle-shaped; and nerve cells, very much elongated and threadlike.

The **germ cells** are special forms of cells that play an important part in the process of reproduction. Each sex produces a characteristic type of germ cell and it is by a union of the male germ cell with a female germ cell that reproduction is accomplished.

8. Female Germ Cells.—A female germ cell is known as an **ovum** (plural **ova.**) The term **egg** is also used with reference to the female germ cell, and the eggs of birds are in reality germ cells that carry with them a large quantity of nourishment for the sustenance of the young bird until it is able to obtain its own feed. In the classes of animals under consideration, the ova are seldom more than $\frac{1}{1800}$ inch in diameter. They are developed in organs known as **ovaries,** from certain cells existing therein. A typical ovum, highly magnified, is shown in Fig. 2, in which the characteristic cell structures previously mentioned are easily distinguishable. The cell body is shown at *a*, the nucleus at *b*, the nucleolus at *c*, and the cell wall at *d*. The structure shown at *e* is merely a protective covering. Notwithstanding the fact that an ovum is exceedingly small, it is nevertheless large in comparison with other cells of the animal body.

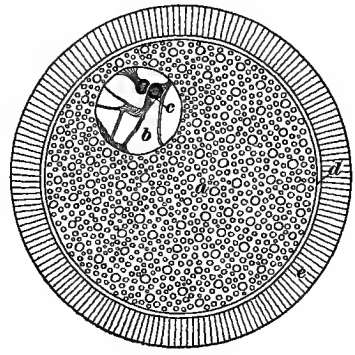


FIG. 2

9. Male Germ Cells.—In somewhat the same manner as the ovaries develop the ova, certain male organs, known as **testicles,** develop the male germ cells, the **spermatozoa.** In general appearance they differ widely from the female germ cells, as will be seen by comparing Fig. 3, which illustrates a spermatozoon, with the ovum shown in Fig. 2. The male

germ cell is usually about $\frac{1}{8400}$ inch in length. Its important parts are a head, or nucleus, *a*, and a tail, or cilium, *b*. By a rapid motion of the latter, somewhat similar to the swimming motion of fishes, the spermatazoon is able to propel itself through a fluid or over moist surfaces. This power of motion plays an important part in bringing the male and female germ cells together, as will be pointed out in the discussion of fertilization. Myriads of spermatazoa are present in the thick, viscid fluid known as **semen,** which is secreted by the testicles and certain other glands. If a drop of normal semen is examined under a compound microscope, the germ cells are readily distinguishable. This is a method sometimes used to test the semen of male animals to determine whether or not they are capable of reproduction. Semen devoid of living germ cells is inactive, and males from which it is obtained are said to be **sterile,** or **impotent,** a condition that may be either temporary or permanent, as is explained under the heading sterility.

FIG. 3

REPRODUCTIVE ORGANS

10. The numerous organs concerned with the process of reproduction are known as **reproductive organs,** or **genital organs.** Their functions are to bring the two reproductive elements—the spermatazoon and the ovum—together and to nourish and protect the young animal until it is capable of maintaining an independent existence. As it is on the female animal that the last mentioned functions devolve, it is to be expected that her genital organs will be more numerous and complex than those of the male, and this is found to be the case in nature.

11. Female Reproductive Organs.—In Fig. 4 is illustrated the general appearance of the reproductive organs of a mare. This illustration is somewhat diagrammatic and is intended to show the relative positions and relationships rather than

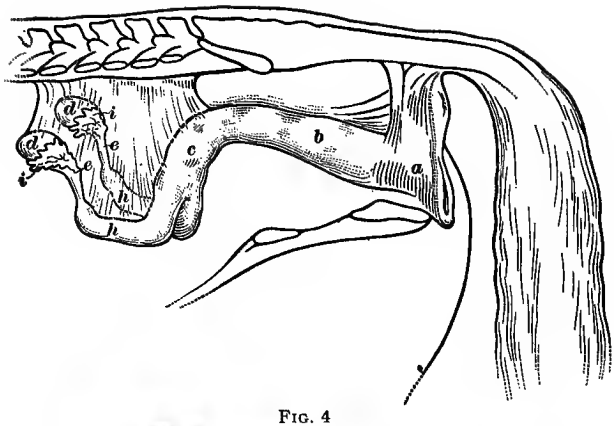


FIG. 4

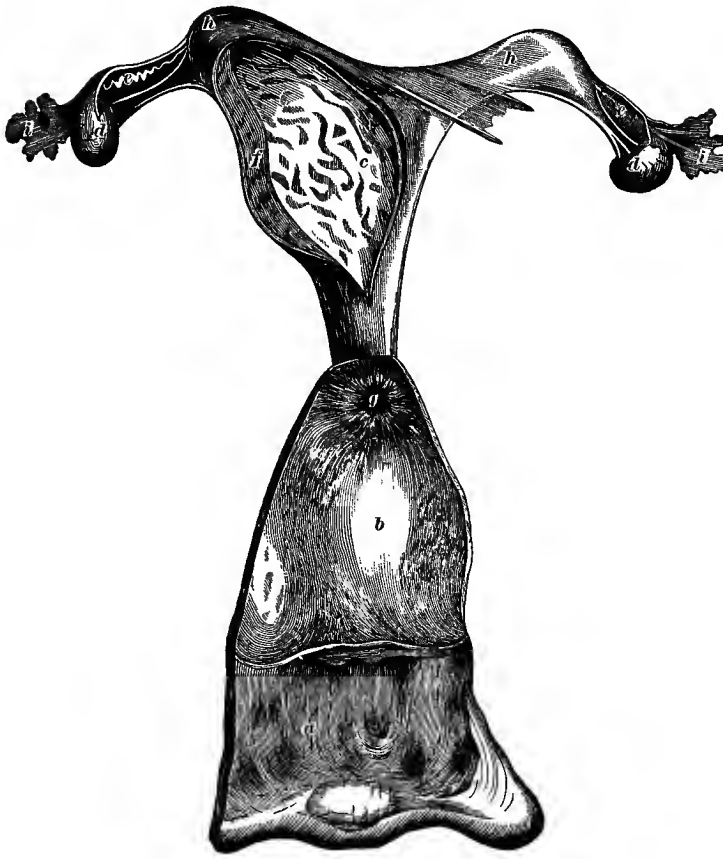


FIG. 5

the actual arrangement. Fig. 5 illustrates similar organs removed from the mare. In this figure the organs are viewed from above, some of them having been opened to give a better idea of their structure. The names of the essential organs, shown in Figs. 4 and 5, are as follows: *a, vulva; b, vagina; c, uterus*, or *womb; d, ovaries;* and *e, Fallopian tubes.*

The **vulva,** consists of a shallow cavity communicating with the exterior through a narrow slit-like opening. In Fig. 5, the upper portion, or roof, of the vulva has been divided and the organ laid open. In addition to the one external opening into the cavity there are two internal openings, one leading to the urinary bladder and the other to the vagina, the second important female reproductive organ.

The **vagina** is a sheath-like organ communicating at one end with the vulva and at the other with the uterus. In Fig. 5 it is shown opened and spread out in the same manner as the vulva. Viewed in this manner it is possible to distinguish its junction with the vulva at one end and with the uterus at the other end, points that are not distinguishable in Fig. 4. At the junction of the vagina with the uterus, the latter projects into the former, as shown at *g*, Fig. 5. This projection is known as the *os uteri*, meaning *the mouth of the uterus.*

The **uterus** itself is a muscular sac in which the young animal is protected and nourished up to the time of birth. For descriptive purposes it may be divided into three principal parts, namely, the body *c* and two horns, or cornua, *h*. At *f*, Fig. 5, the wall of the body is cut and turned back, exposing the cavity of the uterus, which is a continuation, through the os uteri, of the cavity of the vagina. The walls of the uterus are capable of great distension to accommodate the growth of a young animal, and the muscular structure of the walls is necessary for the expulsion of the young at birth.

From the extremity of each cornu of the uterus a tube leads to the ovary on the corresponding side. These tubes are known as **uterine,** or **Fallopian, tubes,** and are shown at *e* in the figures. They form a continuation of the cavity of

the uterus but do not unite directly with the ovaries. Each tube ends in an expanded flower-like structure known as the *pavilion of the tube*, shown at *i*, Figs. 4 and 5, and the opening of the tube is into this pavilion. The latter is more or less in contact with the ovary, but its opening is into the abdominal cavity.

The **ovaries** are two kidney-shaped organs located as shown at *d*, Figs. 4 and 5. Their function is to develop ova, as already explained. When an ovum is fully developed, it bursts from the surface of the ovary and is grasped by the pavilion of the tube. From this point it passes into the tube and is carried along toward the uterus. Its further course will be traced in the consideration of the subject of fertilization.

12. Male Reproductive Organs.—The essential reproductive organs of the male are the *penis*, and the *testicles*, and certain ducts and glands, the details of which it is not necessary to explain here.

The **penis** is an erectile organ by means of which the semen is introduced into the female organs. Except during periods of sexual excitement, the penis is usually encased in a protective covering called the *sheath*. The **testicles** are two in number, and are carried in a pouch known as the *scrotum*, and also as the *cod* and the *purse*. As has already been mentioned, the function of the testicles is to develop the spermatazoa and to secrete a fluid in which the germ cells are suspended. This fluid is carried by ducts to a storage reservoir within the abdomen of the animal. Along the course of these ducts are certain glands that add their secretion to the fluid, the whole constituting the *semen*.

FERTILIZATION

13. At certain more or less regular intervals a developed ovum is released from the ovary and passes along the Fallopian tube toward the uterus. The time of the ripening and passage of the ovum is marked by numerous disturbances in the female, the more noticable of these being irritability of temper,

restlessness, swelling of the vulva, and frequently a discharge from the latter. This condition is known as *ovulation*, *heat*, *rut*, and *œstrum*. Its first appearance in a young female, constituting the beginning of sexual life, is termed **puberty.** From this time on, heat reoccurs more or less regularly, except during pregnancy, until the time at which sexual activity ceases with the approach of old age. Heat usually occurs about every three weeks, although the period varies considerably, depending on the class of animal, climate, feed supply, and other factors. During the period of heat, the female usually gives off a characteristic odor by which the male is attracted. As a rule, it is only during heat that the female will accept the attentions of the male.

14. During *copulation*, the semen is ordinarily deposited in the vagina, but there is evidence that at least a small quantity may be thrown into the uterus. By the swimming motion already described, the spermatazoa penetrate into the horns of the uterus and on into the Fallopian tubes. If an ovum, in passing from the ovary to the uterus, encounters a spermatazoon, the two cells approach; the nucleus of the ovum moves to a position near the cell wall; the nucleus of the spermatazoon penetrates the protective covering shown at *e*, Fig. 2, passes through the cell wall, and unites with the nucleus of the ovum. This constitutes the process of **fertilization,** or **impregnation.** It may take place in the uterus or in a Fallopian tube, probably more often in the latter. In the case of animals that bear more than one offspring at a birth, several ova are fertilized. If, during its descent from the ovary to the uterus, an ovum is not met and fertilized by a male germ cell, the former passes out of the body and is lost.

15. The sexual act by which the semen is deposited in the female organs is known as **copulation.** *Breeding*, *covering*, and *serving* are other terms commonly used by livestock men to designate the same act. Horse breeders often find it an advantage to resort to what is known as **artificial impregnation,** a process by which the semen discharged at one service

of the stallion is utilized to fertilize a number of females. The details of this operation and a description of the instruments required for its accomplishment are given in another Section.

DEVELOPMENT OF THE EMBRYO

16. In the uterus, the ovum, having absorbed the nucleus of the spermatazoon, undergoes a complex process of division, redivision, and folding, the result of which is the formation of the **embryo.** The latter is the name given to the young animal in its earliest stages, before definite structures and body appendages can be distinguished. Later, when the limbs and other appendages are recognizable, the term **fetus** is used in place of embryo. As the fetus grows, it gradually takes on a resemblance to the parental form. Its nourishment is absorbed from the maternal blood as it circulates in the walls of the uterus.

17. The time from the fertilization of the ovum to the delivery of young is known as the **period of gestation.** The average length of the period of gestation in different domestic animals is as follows: Horses and asses, 336 days; cattle, 285 days; sheep and goats, 147 days; hogs, 112 days. It should be noted that these figures are simply averages. Ordinarily there is considerable variation in the length of the period not only among different animals but also in the same animal under different conditions and it is not unlikely that the actual date will fall short of or exceed by several days the time mentioned.

Gestation tables, consisting of an arrangement of dates by which it is possible to determine at a glance the approximate date at which the young will be born, are commonly used and will be given in the various Sections that treat of different classes of domestic animals. In using a gestation table, the breeder simply finds in one column the date on which the female was served. Opposite this date, in a parallel column, appears the date on which the birth of the young may be expected.

BIRTH

18. The expulsion of the fetus from the maternal body marks the close of the gestation period and is known as **birth,** or **parturition.** In the various groups of animals, special terms are used to designate the birth of young. With mares, parturition is commonly called *foaling;* with cows, *calving;* with sheep, *lambing*, or *yeaning;* and with pigs, *farrowing.* There are certain indications by which the breeder is apprised

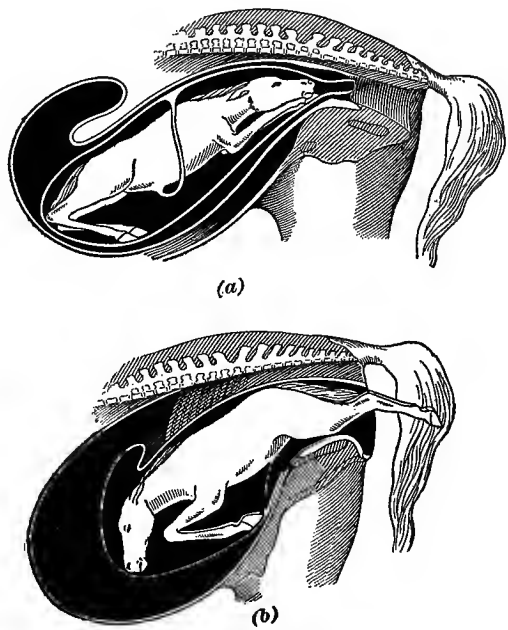


FIG. 6

of the approach of parturition. He may, by observing these indications, make preparations for taking care of the mother and offspring during the critical period. Among the prominent indications of approaching parturition may be mentioned a waxy secretion at the ends of the teats, a swelling of the udder and of the vulva, together with a dropping of the abdomen and a hollowing of the flank. Shortly after the

appearance of these symptoms, or some of them, acute contractions of the muscles of the uterus, known as **labor,** or **straining,** may be expected to begin. Under ordinary conditions this activity will result in the birth of the fetus within the next few hours.

In the delivery of the fetus from the womb the usual position of the former is with the head and forefeet first, as shown in Fig. 6 (*a*). This is known as a *normal presentation.* The presentation shown in (*b*) is also a common one. With a fetus of average size, there is usually no difficulty in the delivery of such presentations, but it sometimes happens that an *abnormal presentation* makes the delivery of the fetus difficult or impossible. An abnormal presentation may consist in a twisted, inverted, or other unnatural position of the fetus or a peculiar position of its legs, thus obstructing its passage through the genital openings. A similar difficulty may result from a swollen or bloated condition of the fetus due to abnormal development or to its death and decomposition within the womb, etc.

In the case of an abnormal presentation, it is often possible, by manipulation, to alter the position of the fetus and thus permit of its delivery. To accomplish this, in the mare or cow, the breeder should first thoroughly clean and disinfect his hand and arm to the shoulder. The utmost care is necessary in this matter, to avoid the introduction of infection into the organs, where it may result fatally to the animal. The arm is then lubricated with vaseline, unsalted lard, or olive oil, and, in an interval between labor pains, introduced through the vagina to the fetus. This work should be performed with the utmost care and gentleness. It is important also to avoid undue excitement of the animal by hasty or violent movements, by the presence of too many assistants, and, in fact, by any condition that may unnecessarily disturb the animal. When the hand has reached the fetus, it is usually possible to determine by careful feeling what its position is. If the presentation is found to be abnormal, it may be possible to change the position of the fetus by bringing pressure to bear on it between periods of straining.

19. It is not the intention to give here explicit directions for dealing with the great variety of abnormal presentations that may occur. In general, the efforts should be directed toward getting the fetus in one of the positions shown in Fig. 6. To do this, it is usually necessary to force the fetus back into the womb before its position can be shifted. To assist in forcing the fetus back, a forked instrument known as a *repeller*, which is shown in Fig. 7 (*a*), is sometimes used. As an aid in turning the fetus within the womb, an instrument known as a *rotater*, shown in (*b*), is sometimes used. A cord is passed through the eyes of the instrument, forming a

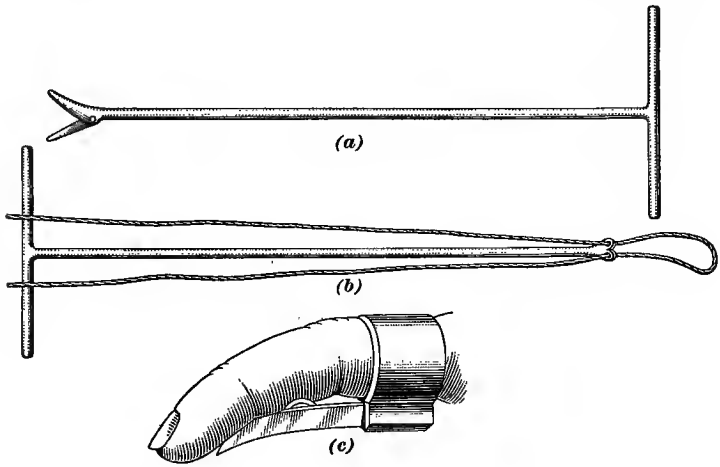


FIG. 7

loop as shown. The end is then introduced into the womb and the operator, with his hand, adjusts the loop of cord to the fetus in such a way that when the handle of the instrument is rotated there will be a tendency to turn the fetus in the desired direction. In some extremely complex cases it becomes necessary to sever one or more of the limbs of the fetus or even to dissect the body in order to accomplish its removal from the dam, the life of the young animal being sacrificed to save the mother. This operation is also frequently required in cases of a distorted or a bloated fetus. For the dissecting operations within the uterus, an *embryotome*,

shown in (*c*), is of great assistance, as the blade may be guarded by the finger at such times as it is desired to avoid cutting.

Other instruments, such as hooks, forceps, and chisels, are sometimes employed by professional veterinarians in difficult labor cases, and in all but the most simple operations it is doubtless well to call a qualified veterinarian, particularly if the animal is a valuable one.

FIG. 8

With sheep and swine, few of the preceding manipulations are possible on account of the smaller size of the genital organs of these animals. In cases of difficult lambing or farrowing, an instrument known as *lamb and pig forceps* is commonly used. There are several forms of this instrument, one of which is shown in Fig. 8. The instrument may be introduced into the womb and utilized to a certain extent in the same way as the other instruments described.

ABORTION

20. Occasionally it happens that the fetus is delivered prematurely—that is, before the expiration of the normal period of gestation. When such a premature delivery occurs late in the gestation period, say at a time when the fetus is sufficiently developed to permit of its being saved, the event is commonly referred to as a **premature birth.** If delivery occurs earlier, say, at a time when the fetus is so imperfectly developed as to be incapable of living, the act is referred to as an **abortion.**

Abortions are frequently caused by injury or undue muscular exertion of the dam. Blows, kicks, slipping on ice or wet ground, crowding through narrow doors or gateways, piling up in sleeping quarters, and drinking excessive quantities of ice-cold water, are some common circumstances

that result in abortion. Certain pasture weeds and fungus growths, particularly the smut of rye, known as ergot, are also responsible for abortion.

Abortion due to the causes mentioned is spoken of as **non-contagious abortion,** to distinguish it from a form due to the infection of the female genital organs with germs. The latter is referred to as **contagious abortion,** and is especially prevalent among cattle, although it affects also sheep and swine and will be discussed more fully under a Section devoted to animal diseases.

STERILITY

21. Occasionally animals are found that are incapable of reproduction. This condition is known as **sterility,** and may be due to various causes. Overfeeding, resulting in an excess of fat, together with lack of exercise, are perhaps among the common causes. In the female, sterility is frequently due to closure of the os uteri, which prevents the entrance of the semen, as well as to the presence of acid secretions, which destroy the spermatazoa. If the sterile animal is not of special value on account of purity of blood or pedigree, it is perhaps well to discard it for breeding purposes. In the case of valuable animals, however, a veterinarian should be consulted, as it is often possible to correct the condition.

LAWS OF BREEDING

LAW OF HEREDITY

22. In the reproduction of animals there is a force or a tendency operating to keep offspring like their parents. This force or tendency is known as **heredity,** and its application as the **law of heredity,** or the **law of inheritance.** *Like produces like* is a brief and pointed statement of this same law.

The tendency of offspring to resemble the parents is so strong and so constant that it is natural to suppose that there is some physical basis for it—that is, some actual substance existing in the ovum and spermatazoon that carries the characters of the parent to the offspring. Scientists are generally agreed that there is such a physical basis for this transfer, but there is a wide difference of opinion as to just what this basis is and how it performs its work. Many theories have been advanced and may be found expounded in works on evolution, but they are at present nothing more than theories.

It is important to note that the law of inheritance may apply not only to the organism as a whole but also to any peculiarity of form or function. The older works on animal breeding devote a great deal of space to illustrating the law of inheritance by pointing out instances of the transmission of minute and often insignificant peculiarities from parent to offspring. This application of the law is not so important to the breeder, however, as is the broader application that refers to the transmission of the general characters of the individual as a whole. It is this latter, rather than some unimportant point of form or structure, that chiefly concerns the man who is seeking to improve his domestic animals.

23. Direct Heredity.—The most common action of the law of heredity is that which results in offspring closely

resembling the immediate parents, and is called **direct heredity.**

When it continues from generation to generation, heredity is said to be *strong*, the type is said to be *fixed*, and the animals are said to *breed true to type*. If the history of a certain type for several generations back is known and the fact is established that all the individuals of these generations have been uniform, there is reasonable assurance that this uniformity will continue. Such a continuation is a demonstration of direct heredity.

Three factors operate to affect direct heredity. In other words, the probability of offspring closely resembling the parents depends on three conditions. These are:

1. The purity of the blood of parents; that is, freedom from an admixture of other blood for a considerable number of generations.
2. The similarity of the parents, or, in other words, the degree to which the parents resemble each other.
3. The degree of relationship of the parents, which is a question of the blood relation of one parent to the other.

From the preceding it is evident that parents of comparatively pure blood, closely resembling each other and closely related, are much more likely to transmit their characters to their offspring than are parents lacking one or more of these requirements.

24. Indirect Heredity.—The appearance in the offspring of characters not found in the immediate parents but in the more remote ancestors is called **indirect heredity.** This form of heredity usually manifests itself in some particular trait or character rather than on the animal as a whole. The unexpected appearance of an ancestral character is called *atavism*, *reversion*, *harking back*, or *striking back*, and it is frequently the cause of considerable annoyance to the breeder who is trying to get rid of some character or quality. He may have apparently succeeded in eliminating the undesirable point, only to find it reappearing unexpectedly in later generations. It is not known how long a character may

lie dormant, but there are instances of the occurrence of atavism after many years of direct heredity. As a rule, however, after the first few generations the chances of the appearance of atavistic characters are rather remote. Individuals that show atavistic characters do not, as a rule, transmit these characters to their offspring, the latter being more likely to possess the characters of the grandsire and grandam.

Some authorities consider that the case of a male parent, for example, transmitting to his female offspring the characters or qualities of his dam, is a further example of indirect heredity, but others are inclined to regard this as direct heredity. Among dairy cattle, there have been numerous conspicuous examples in which sons of a particularly good milch cow have transmitted this quality to their female offspring. In the same way, a daughter of a sire possessing certain strong masculine traits may transmit them to her male offspring. These are cases of the transmission of characters that depend on sex itself being transmitted strongly by the opposite sex. This may also apply to characters that are not distinctly sexual. Thus, a bull may stamp his female offspring with a certain color mark that is absent from his male offspring.

25. Inheritance of Disease.—The question of the inheritance of disease is an important one, and in the literature of breeding it will be found that almost every disease in the whole list of animal ailments has, at one time or another, been considered to be hereditary. It is undoubtedly true that in many cases certain diseases pass from generation to generation with a good deal of regularity, and there is reason to believe that this is sometimes due to the hereditary transmission of the disease to the offspring by the parent. The study of disease has, however, brought about a marked modification of early views regarding the inheritance of disease. It is now known that many diseases are the direct result of the presence of bacteria in the animal body. In the case of such diseases, the infection is rarely passed directly

from parent to offspring by heredity. This statement, however, has nothing to do with the infection of offspring from parent by other means than heredity. A cow affected with tuberculosis, for example, is not likely to infect her offspring with the disease as long as the fetus is in the uterus, but after birth, if the calf is kept with the dam, infection is almost sure to result from their intimate association.

There are, however, certain general constitutional diseases, particularly those affecting the structure and conformation of the skeleton, that are still generally recognized to be more or less hereditary, and animals suffering from any such diseases should not be used for breeding purposes. For example, the cow affected with tuberculosis may not transmit the actual disease germs to her calf by heredity, but she may transmit a weak constitution and certain other defects that are favorable to the development of the disease in the calf, which defects the cow has inherited from her parents.

26. Inheritance of Malformations and Mutilations.—In the course of breeding operations there are occasionally born individuals in which some organ or structure is abnormally developed, greatly modified, or supernumerary. In other cases, an organ or a structure may be imperfectly developed or absent. Such abnormalities are referred to as **malformations.** Examples of malformations are: limbs of unusual size or shape; an extra limb; a small, imperfectly developed limb; or the entire absence of a limb; however, the malformed part is not of necessity a limb; it may be almost any other body structure or almost any body organ.

Mutilations may be described as malformations due to accident or design, and usually consist of cut, broken, or injured parts or parts that have been purposely removed, such as the horns, tail, etc.

If an animal having a malformation or a mutilation is to be used for breeding purposes, a question arises as to whether the offspring will inherit these imperfections or alterations. There is a well-established popular belief that these departures from the normal are transmitted to offspring of parents

possessing them, and numerous examples are cited in support of this belief. On the other hand, the best authorities on breeding incline to the belief that malformations and mutilations are not transmitted and point out the fact that the examples cited are largely traditional and that undoubtedly many of the remaining ones may be attributed to mere chance. There are a few apparently authentic cases on record in which a malformation or a mutilation has been transmitted to offspring, but it may be safely said that the probability of this occurring is very remote. A striking instance of the non-transmission of mutilations is in the case of docking—that is, removing the tails of animals. Notwithstanding the fact that docking has been practiced for many years upon sheep and certain breeds of horses, the character shows no tendency to diminish or to disappear.

27. Inheritance of Acquired Characters.—Probably one of the most controverted questions relating to evolution in general and animal breeding in particular is the question as to whether acquired characters are transmitted to the offspring of parents possessing them. It seems likely that at least some of this controversy has arisen from different understandings or interpretations of the term *acquired character*. In the sense here used, an acquired character does not signify an entirely new character acquired suddenly by an individual and not appearing in its ancestors. It has reference, rather, to a character or quality that is highly developed or specialized in an individual as compared with its development in the ancestors. It is not, therefore, the quality itself but its unusual development or specialization that is acquired. A cow may develop the quality of increased milk production, which may be regarded as an acquired character, though the character of milk production has, of course, been possessed by her female ancestry for countless generations.

The disputed point is, will such an acquired character be transmitted to the offspring of the parent possessing them? In other words, will the female offspring of the cow exhibiting the acquired character of increased milk production inherit

this character from her; or will they possess merely the average of the ancestors? It should be carefully noted that this question has no reference to inherited characters or to characters that may appear as the result of a variation or atavism. Many good authorities hold strongly to the idea that the parent does not transmit to its offspring any qualities or characters that it, the parent, may have acquired during its life. On the other hand, equally distinguished investigators maintain that such characters are transmitted to the offspring, and it should be stated that practical breeders, without exception, base their operations, and particularly their selections, on the idea that acquired characters are inherited by offspring. In other words, they hold that an animal possessing the quality of increased production of milk, flesh, wool, or speed transmits to its offspring a tendency to the same increased production. Obviously, the work of the breeder is greatly facilitated if this is true. It is not possible, with the knowledge available at the present time, to state positively that the proposition is true or untrue, and breeders will do well to take this fact into consideration and conduct their operations accordingly.

28. Mendel's Law of Hybrids.—Certain characters of offspring are the result of a combination, or blending, of the characters of the parents. For example, if, among cattle, a pure-bred red male of one breed is mated with a pure-bred white female of another breed, the offspring may be roan in color, provided the colors, red and white, are equally strong in hereditary influence. If one color—the red, for instance—is much stronger in hereditary influence than the other—white—the offspring are likely to be red or at least a very dark roan. In either case, the offspring are hybrids. If, now, a considerable number of these hybrids are produced from the same parents or from parents exactly similar in regard to the characters mentioned, and these hybrids are interbred, the resulting progeny will tend to be red, roan, and white, in accordance with a definite law known as **Mendel's law of hybrids,** so named from its discoverer.

The first application of Mendel's law was to the breeding of plants, but it has been found to hold true also in the breeding of animals. It should be noted, however, that in the following description the simplest possible case is chosen for the sake of making the theory clear. In actual practice, there are may factors that will enter and complicate the working out of the law. Suppose that a herd of red and a herd of white animals similar to the first two individuals just described are isolated from all other cattle and allowed to interbreed. Two cases must be taken into consideration.

1. The first case to be considered is that in which the two colors, red and white, are equally effective in determining the color of the offspring. In this case, the offspring will be roan in color, which represents an equal blending of the colors of the parents These roan animals constitute the first generation. If, now, these roan animals are interbred, the offspring, representing the second generation, will, according to Mendel's law, exhibit a variety of colors: One-half of them will be roan, similar to their immediate parents; one-fourth will show the red color of the one grandparent and the other one-fourth will show the white color of the other grandparent. Thus, if from the herd of roan hybrids of the first generation one hundred calves are produced, fifty will be roan, twenty-five will be red, and twenty-five will be white. If now all of these groups are isolated and interbred, that is, the whites bred to whites, the reds bred to reds, and the roans bred to roans, an interesting result is observed. The whites will produce pure whites and the reds will produce pure reds. In other words, the mixture of red and white blood that occurred to produce the first generation has had no apparent effect on these animals. This result will hold true throughout all succeeding generations of these animals, provided there is no subsequent admixture of foreign blood. But the offspring of the fifty roan animals will continue to show mixture: one-half of them will be roan, one-fourth red, and one-fourth white. This constitutes the third generation. As before, the red animals, if interbred, will produce pure reds, and the whites, if interbred, will produce whites; but

the roans will again split up into one-half roans, one-fourth reds, and one-fourth whites. Thus the process will go on indefinitely.

2. Suppose, now, that another case be taken in which conditions are exactly the same at the beginning as detailed in the first case, except that, instead of being equally balanced, one of the colors, say red, is much more influential than white in determining the color of offspring. Under these conditions the red is said to be a *dominant character* and the white is said to be a *recessive character*. In the first generation, the offspring, instead of being roan, will be red, for the red color is predominant over the white. In the second generation, if one hundred animals are produced, there will be twenty-five white and twenty-five red animals, these representing the pure forms; but the remaining fifty, which in the first case were roan, will now be red on account of the predominance of the red color. Therefore, the second generation will contain one-quarter white and three-quarters red animals. Now, although the one-quarter that are pure red and the half that are red because the latter color is dominant over the white may look exactly alike, the latter are nothing but hybrids. When the pure reds are bred together, the result will be pure red offspring; but when the fifty red hybrids are bred together, one-quarter of the offspring in the third generation will be pure white, one-quarter will be pure red, and one-half will be red hybrids, due, again, to the dominance of the red color, and the succeeding generations will be in accordance with the same principle.

This, in exceedingly brief form, is Mendel's law, stated in its simplest terms and illustrated by means of an imaginary herd of animals. In practical breeding operations, it is difficult to obtain the results set forth. Many factors, such as variation and atavism, would be likely to have an effect in determining the final result. In case the hybrids are of the same color as one of the pure-bred divisions, it would be difficult, if not impossible, to separate the two. Furthermore, it is likely that the red color would be partly rather than completely dominant over the white, which would further

complicate the experiment. However, the preceding discussion serves to illustrate the principle, which has been demonstrated to be true, and notwithstanding the complications that are encountered in actual practice, progressive breeders are beginning to take Mendel's law into account, endeavoring to make it serve a useful purpose.

LAW OF VARIATION

EXPLANATION OF THE LAW

29. In addition to the law of heredity, which operates to produce offspring that resemble the parent forms, there is another law constantly active that tends to produce offspring that are unlike the parents. This second law is known as the **law of variation.** By its operation, the production of exact duplicates is prevented. Not only are differences evident between parents and offspring, but also between individual offspring of the same parents. Thus, although the law of inheritance is that offspring tend to resemble their parents, the law of variation is that they tend to differ from them; and, notwithstanding the apparent contradiction, both laws hold true. Likewise, both are so familiar that a moment's consideration demonstrates their truth. The two laws are closely associated and should be considered in their relationship to each other in breeding operations. Both play an important part in the work of animal breeding. If the law of inheritance were fixed and inviolable, there would, of course, be no possibility of bringing about an improvement by animal breeding. On the other hand, if there were no law of inheritance, types, breeds, and families would cease to exist as such, and there would be only a heterogeneous mass of individuals instead of species, varieties, breeds, and families, many of which have existed from prehistoric times.

The law of variation tends to the production of slight rather than violent changes, and, moreover, it applies to all

characters—not simply to certain ones. Consequently, there is said to be a slight but constant tendency to vary. In this connection, however, it is important to note that different kinds of animals show different degrees of variation. For example, certain families or individuals may show few and small variations, and other families or individuals may show numerous and great variations. The former are referred to as *fixed types* and the latter as *variable types*.

DEGREES OF VARIATION

30. Variations are, in a sense, departures from the general forms and characters of the parents. These departures may be very slight or very radical or intermediate between the two extremes. Hence, it may be stated that there are different *degrees of variation*, considered from the standpoint of the extent to which the variation departs from the parental form.

The degrees of variation commonly recognized by breeders are: normal variations, discontinuous variations, abnormal variations, malformations and monstrosities. It will, of course, be understood that these are arbitrary divisions and that forms intermediate between these different divisions may occur. The first two degrees mentioned are of such nature as to be of assistance to the breeder, but the remaining ones are so extreme as to interfere more or less seriously with the usefulness of the animal possessing them, and are therefore of little interest except as examples of the principle of variation.

31. Normal Variations.—Variations that constitute just a sufficient departure from general type as to make it plain that variation exists, are called **normal variations.** Normal variations, particularly in animals that are of a uniform type, are so small that it often requires a minute examination or an intimate acquaintance with the individual in order to recognize them. Familiarity with a flock or herd is, of course, a great aid in recognizing normal variations in the domestic

animals. The herdsman, for example, detects at a glance minute variations that would not be apparent to one unfamiliar with the herd. It is his ability to recognize these differences in individuals that gives the breeder a large part of his skill in the improvement of domestic animals.

32. Discontinuous Variations.—Variations that are so marked or peculiar as to be unusual, yet not radical enough to be classified as abnormal variations, malformations or monstrosities, are referred to as **discontinuous variations.** A discontinuous variation may affect the color, form, size or any particular character of an individual, and is sufficient to mark the latter at once as distinct from its parents and from the general mass of the breed. At the same time, the individual is not so radically different from its breed that the relationship is not at once recognized. Breeders commonly refer to discontinous variations as *sports*. Ordinarily the departure from normal shown by a sport disappears in the next generation; that is, the sport does not transmit its peculiarities to its immediate offspring. In fact, it has often been found impossible to perpetuate a sport, even when every effort is made to do so. On the other hand, in occasional cases, sports occur and perpetuate themselves, thus giving rise to new types that remain practically permanent from the start.

33. Abnormal Variations.—Variations that are more radical than a sport but not so radical as to affect the vital parts of organs sufficiently to interfere with the life function are considered to be **abnormal variations.** An extra limb or other structure or an extremely peculiar marking of the hair or skin may be given as illustrations of an abnormal variation.

34. Malformations.—Variations that are of a still greater degree than abnormalities and are sufficient to interfere to some extent with the vital function of the animal but not so much as to make it impossible for the animal to live, are called **malformations.**

35. Monstrosities.—To the class of variations comprising still more radical forms than the foregoing and of such a nature as to make life impossible for more than a comparatively short time after birth, the name **monstrosities** is given.

EXTERNAL CAUSES OF VARIATION

36. Environment.—Perhaps one of the most important external influences causing variation in domestic animals is **environment,** which has reference to external conditions of life, such as climate, food, care, etc., to which the animal must adapt itself. Considering climate, it is, of course, well known that there is a certain relation existing between animals and the climate in which they live. All sorts of animals are found in all sorts of climates, but the same class of animals existing under different conditions of climate will exhibit certain characteristics that are more or less directly due to climatic influences. These characteristics are, in general, those that affect the size and the external covering of the animal. As a general rule, animals inhabiting cold climates are smaller than those of the same species living in warm climates. The free working of this principle, however, is interfered with among domestic animals owing to the fact that man, by furnishing shelter, modifies the effect of climate to a greater or less extent, and in this way is able to move animals from one climate to another without deterioration. Ordinarily, it will be found that animals that have been developed in cold or severe climates are hardy and vigorous, although this is not always true.

There are many examples of domestic animals that have been transplanted from their native country, or the country in which they were developed, to other countries widely different in climate, and have still continued to thrive, in some cases even showing improvement over the original types. As an example, the Merino sheep may be cited. This breed was originated in the dry climate of the table lands of Spain, where the sheep attained a high degree of development in the production of wool of great fineness and

softness. In the latter part of the 18th century, animals of this breed were exported in considerable numbers to Germany, France, and the United States, and in each of these dissimilar climates they not only maintained their vigor and general characteristics, but in each case increased in development in some one particular character. Another example is the Jersey and Guernsey cattle of the Channel Islands. These cattle have been brought in large numbers to the United States, where they have spread through the whole country, in no part of which are the climatic conditions at all like those of their original habitat. Nevertheless, they have shown no loss of vigor, have become thoroughly acclimated, and many individuals have shown as great or greater productive capacity than the original animals imported. So far as adaptability to climate is concerned, there seems to be no reason why any useful breed may not be transplanted to a climate widely different from that in which it was developed.

37. The effects of the care given to domestic animals by man are seen in various ways. It is generally admitted that because of it many of the females deliver their young in a less mature state, less able to take care of themselves, than was the rule under natural conditions. This, it is believed by some authorities on animal breeding, follows as a direct result of the shortening of the gestation period. This is notably the case in the domestic pig, and amounts to as much as 4 days as between the improved domestic swine and the wild hog. It has often been remarked that the young of highly bred animals are apparently weak; from this it is argued by some that animals of this kind are commonly weak in constitution. This, however, is not accepted by breeders of pure-bred stock. The young of highly bred animals, being born in a less mature state, require from man more care and better protection, but it is pointed out that at an equal period of development they are just as vigorous and able to care for themselves as their unimproved relatives that were born more fully developed.

38. The environment of domestic animals is also influential in the development of certain traits or instincts and the loss of others. For example, the instinct to protect its young is undoubtedly one of the strongest forces in wild animals, but through the influence of man's care, in certain of our breeds of domestic animals, this maternal instinct has been almost entirely obliterated. This is particularly the case in certain of the dairy breeds in which, when a cow drops her calf and the calf is removed from her presence, she does not appear to miss or mourn for it.

39. Another factor to be considered in connection with environment is that of feed supply, and it is undoubtedly one of the most important ones. As a matter of fact, the first cause of all improvement may be said to be an increase in the quantity, quality, and regularity of the feed supplied. The question of the maintenance of the quality of improved animals depends on the care and skill with which they are fed. If an improved animal is to maintain itself and produce young that will be as good or an improvement on it, it must constantly have all the good feed that it can use. Improved animals not only consume more feed than ordinary animals but they make better use of it. If the feed supply of such animals is cut off or reduced, it is generally admitted that they will still make better production in a broad sense than unimproved animals on the same supply of feed, but reversion and deterioration are almost sure to follow such reduction.

40. Telegony.—A second external cause to be mentioned as giving rise to variation is known as **telegony,** which is the influence of the sire of one offspring on the succeeding offspring from the same dam and a different sire. An incident that is commonly used in support of the belief in telegony is the following: More than 100 years ago an English breeder, Lord Morton, is said to have crossed a thoroughbred running mare with a quagga and in time a zebra-striped foal was produced. In the succeeding year the mare was not covered, but the second year after was covered by a thoroughbred running sire, and from this union a foal marked with stripes

was produced. Similar instances, it is claimed, have been observed in numerous cases with other classes of animals. Extremists even claim that a female that has produced young other than that of her own breed is thereby reduced to the class of a grade animal and can never be depended on to breed true when mated with males of her own breed. Several very ingenious theories have been brought forward to account for such occurrences, but none of them are entirely satisfactory. On the other hand, it has been claimed that none of the supposed cases of telegony are authentic and that even Lord Morton's mare was a myth and that there is no such thing as an influence of this sort. The experiment of crossing a quagga on an Arabian mare has been repeated with negative results as to telegony. Some of the recorded cases of telegony are apparently so authentic as to demand recognition, but the present view of those on whose judgment most dependence can be placed is that cases of telegony, if such a thing does exist, are extremely rare, and that telegony as a factor in variation need not be taken into serious consideration by the breeder.

41. Prenatal, or Intra-Uterine, Influences.—There is a more or less prevalent belief that the color of the offspring may be influenced by presenting the desired color before the dam at the time of copulation, or by confining her during the period of gestation in enclosures in which the desired color predominates. Along somewhat the same line is the belief that a deformity or mutilation presented unexpectedly to the sight of the dam during the period of gestation is likely to result in the appearance of a corresponding abnormal condition in the offspring. **Prenatal,** or **intra-uterine, influences** is a term used to designate the causes that bring about such results. The belief is that the mental impressions of the dam are transmitted to the young within the womb and the development of the young affected thereby.

Many examples are cited by believers in this theory, and some of them are apparently authentic. Scientists are, however, practically agreed that there is no such transmission

of impressions, and that the seemingly authentic cases are accidental rather than the operation of such influences. It should be noted that the preceding does not apply to influences that the dam may exert on the fetus through a diseased condition of her reproductive organs, lack of nourishment, violent exercise, etc. There is no question but that the fetus is affected by the latter influences.

BREEDING OPERATIONS

SELECTION

42. The number of young produced by animals, both wild and domestic, is ordinarily much in excess of the number that can mature, live, and breed. Under natural conditions, this excess results in a struggle among the individuals, in which the weaker ones are overcome and only the strong survive to perpetuate their species. This struggle is known as **natural selection.** Among domestic animals the struggle is much modified or entirely eliminated. Man chooses from the total those animals that he desires to use for breeding purposes and makes some other use of the remainder. This operation of choosing animals desired for breeding purposes is known as **artificial selection,** and is perhaps one of the chief factors utilized by breeders in improving their herds. The practical breeder bases his selections on certain qualities, and the degree to which these qualities are present determines whether or not a particular animal is to be used for breeding purposes.

43. Individual Merit.—One of the first qualities required of a breeding animal is **individual merit,** by which is meant the degree to which it approaches perfection as a representative of a breed or a type. The object of breeding is improvement, and it is therefore to be expected that the breeder's interest lies in making use of the most meritorious forms available.

44. Pedigree.—As commonly used, the term **pedigree** signifies a record of the ancestry of an animal extending back through a variable number of generations. If the ancestry shows a strong line of individuals having no admixture of inferior or outside blood, the pedigree is said to be *good*. If, on the other hand, the record shows numerous inferior or unknown individuals or mixture of other strains, or if it does not extend back far enough to show what the parentage has been, the pedigree is said to be *weak* or *poor*. From this it is evident that pedigree is an important consideration in the selection of animals for breeding purposes.

45. The question often arises as to whether the individual merit or the merit of the ancestors, that is, good pedigree, is of most importance in determining the character of offspring. It is unfortunately true that many individuals of surpassing excellence fail to beget offspring of equal excellence with themselves. The reason for this is that, no matter what the individual merit of the individual animal may be, unless it has inherited these meritorious qualities from its ancestors it cannot be expected to transmit these qualities with any degree of uniformity or certainty. It is often stated that a good individual that has no pedigree or a poor pedigree cannot beget offspring of equal excellence, but this is not exactly true. It may accomplish this in some cases, but it cannot be depended on to do so with certainty. The offspring of such an animal are not uniform.

46. It is perhaps equally unfortunate that an individual having a marked deficiency, but descended from good ancestors, may transmit to its offspring not its own deficiency but the excellence of its ancestors. Among breeding animals, it is not an uncommon occurrence to find an animal of mediocre or poor quality that uniformly begets offspring of a much higher quality than itself. The power to do this is ascribed to the high quality of its ancestors. In this case the animal is said to breed better than itself because of the excellence of its pedigree, and the inexperienced breeder makes the mistake of supposing that such an animal, which can

often be purchased at a low price, can be used as a means of improvement. The fallacy of this is almost sure to be apparent when the offspring of such an individual are used for breeding purposes. It will be seen at once that they are of the kind described in the preceding paragraph. They may be excellent individuals, but their immediate parents were inferior and they cannot be depended on to transmit their qualities to their offspring. Hence, the statement that it is unfortunate that an animal with a marked deficiency may transmit to its offspring not its own deficiency but the excellence of its ancestors.

There is perhaps one condition under which the use of such an inferior animal for breeding purposes may be of advantage. When it is discovered that this individual begets offspring of uniform excellence and it is desired to produce only market stock, such an animal may be of value because succeeding generations need not be thought of and it is only the immediate offspring that need be taken into consideration.

47. Prepotency.—The ability of an individual to transmit its characters to its offspring is called **prepotency.** A sire or a dam having this power is said to be **prepotent.** As an illustration, the case of a bull having certain distinct or peculiar color markings may be cited. If the progeny of this bull are practically all marked with the same color character, the bull is said to be prepotent with reference to this character.

Prepotency may vary from a slight preponderance of the characters of one parent to an almost complete resemblance to one parent and the almost complete exclusion of resemblance to the other parent. Prepotency is not confined to sex, for either the male or the female parent may be prepotent in respect to any or all qualities. It very frequently happens also that one parent is prepotent in respect to one character, or set of characters, and the other parent is prepotent with respect to different characters.

Prepotency as a factor in the selection of animals is often extremely puzzling to the breeder, because it may be of either

advantage or disadvantage. It is, of course, evident that when a parent shows prepotency with respect to an undesirable quality such prepotency is a disadvantage. Furthermore, prepotency may not always be of advantage when it is shown with respect to a desirable quality, as will be explained later. It is generally recognized that prepotency is likely to be found in animals having a long line of pure-bred ancestors. But prepotency is also an inherent character of the individual. In the history of livestock breeding, many individuals have been bred in which this quality of individual prepotency was so strong as to give them great fame for the uniform resemblance of their offspring to each other and to their parent.

28. Most domestic animals are polygamous, that is, the males mate with numerous females; therefore, the advantages of prepotency are most apparent when the desirable prepotent quality exists in a well-developed, vigorous male of a desirable type, who, by reason of this quality, begets a large number of uniformly good offspring resembling himself. Prepotency in a male is often an aid in this way to increase desirable qualities and uniformity of a herd or flock. When prepotency is thus utilized in the production of offspring for market purposes alone, there can be no question of its great usefulness. But prepotency may be a disadvantage when a strongly prepotent animal is selected to mate with females lacking in this respect and often of mediocre or inferior merit. The immediate offspring may show a great degree of improvement and uniformity, but they are not likely to prove prepotent; and when, in turn, they are used for breeding purposes they are likely to show in their offspring at least some of the inferior qualities of their dams. In other words, the use of a strongly prepotent male on females inferior in quality to him is much the same thing as using a pure-bred sire on common or mixed-bred females in the production of grades. In the latter case, it is often of no advantage, and may be a distinct disadvantage, to use a very prepotent animal in the production of animals that in turn are to be used for breeding purposes.

49. Constitution.—The successful breeder must take constitution into account in making his selections. **Constitution** refers to all those factors which have to do with the life processes of an animal. These include the digestion and absorption of feed, the circulation of the blood, breathing, the appetite, etc. Naturally, an animal, no matter what other characters it may possess, must be endowed with a strong constitution in order to be of the greatest value to its owner. There are two points that are of value in determining whether or not an animal possesses a good constitution. These are *size* and *symmetry*.

Considering first the question of size, it may be said that an animal endowed with a strong constitution and given an abundant supply of feed will almost invariably develop to more than the average size of its fellows that have not had these favorable conditions. On the other hand, an undersized animal usually means that it is either lacking in constitution or that its feed supply has been deficient. In this way size may to a certain extent be taken as an indication of constitution and an undersized animal avoided for breeding purposes. It should be noted, however, that a few individuals in almost all classes of animals develop to such a size that, as compared with the average of their race or breed, they may be considered as overgrown. They are in effect giants, which seldom have strong constitutions, and are therefore as undesirable for breeding purposes as are undersized animals. From the preceding remarks it will be seen that the best indication of strong constitution is, in regard to size, found in animals above the normal but still under the extraordinary.

The second character by which to judge constitution, namely, symmetry, refers to an even and uniform development of all parts of the animal. A decidedly symmetrical animal is one that presents nothing striking to the eye at first, but on closer examination is seen to possess general superiority, or at least to excel in characters of form and feature. Attention is often drawn to an animal by reason of some very striking character, as a very large udder, a very

prominent eye, or a very long tail. Such animals are unsymmetrical, and although the characters in question may be desirable and useful in themselves they are the marks of a somewhat unbalanced animal. Symmetry, as an indication of constitution, is to be regarded in much the same manner as size. It is the symmetrical animal—that is, the one that is good in all but not strikingly superior in any single character—that is likely to have the best constitution. The idea of symmetry is, of course, modified according to the group of animals under consideration. For example, the body form that is considered symmetrical for the trotting horse is quite unlike the form that is considered symmetrical for the draft horse.

50. Fecundity.—Another factor to be considered in the selection of animals for breeding purposes is **fecundity.** This term has reference to the activity of an individual in the production of young. Animals that bring forth young frequently, regularly, and, in the case of those that bear more than one offspring at a birth, in large numbers, are said to be *fecund.* This quality is of great importance in domestic animals, and it is one that appears to run strongly in hereditary lines; that is, it is capable of being inherited. Increased fecundity manifests itself in numerous ways. First, the parent begins to bear young earlier and continues to be prolific for a longer time than is the general rule; second, the parent gives birth to young regularly during the prolific period; third, in the case of certain groups of animals, swine, for example, more young are produced at a birth.

In wild animals, the capacity for reproduction is held in check by unfavorable conditions of environment, and large numbers of young fail to reach maturity, so that the rate of natural increase is small. When, through domestication, conditions of environment are made more favorable, the possibility of reproduction is enormously increased, and it is found that all domestic animals reproduce more freely than their wild relatives. This increase, however, does not occur until the full effect of domestication has had time to operate.

The captive wild animal often fails to breed or breeds only with great difficulty, and in the newly domesticated animals the habits of reproduction are among the last to change.

But there is another feature of fecundity that must be taken into consideration, namely, that of reduced fecundity due to certain conditions of domestication. The extreme development of some of the improved breeds of animals, notably the meat-producing breeds, which are often kept fully fattened, more or less seriously interferes with capacity for reproduction. As a result of this, many highly developed individuals are either shy or rare breeders. It is with this class of animals in particular that the skill of the breeder is taxed to the utmost to produce a high development of the individual without serious loss of fecundity.

51. Mating.—In the selection of breeding animals, **mating,** that is, the suitability of two animals to be bred together, must be given attention. It should be explained at this point that various names are given to the offspring of different matings. When individuals of two different breeds, species, or genera mate, the offspring, if any is produced, is known as a **hybrid.** The mule, resulting from the union of a jackass and a mare, is a familiar hybrid. In many cases the crossing of individuals of different species does not result in the production of offspring.

When an individual of one breed is mated with an individual of a different breed of the same species, the offspring is sometimes referred to as a **cross-breed.** Unfortunately, this same term is frequently used with reference to the result of mating two individuals not of different breeds but of different families of the same breed. It must therefore be borne in mind that the term *cross-breed* has these two meanings.

A **pure-bred animal** is one whose parents for several generations back show no admixture of outside blood. The offspring of one pure-bred parent and one parent of mixed or unknown breeding is termed a **grade,** and when both parents are of mixed or unknown breeding the offspring is known as a **scrub.** The term **native** is used synonymously with scrub,

although the former should be limited to scrubs that are native to a given locality.

52. Mating is one of the most important operations in breeding and it therefore merits the careful consideration of breeders. Offspring tend, in general, to resemble the parents; but, since no two individuals are alike, and every offspring must have two parents, it follows that, while resembling its parents in a general way, it must differ more or less from each of them. In comparing an offspring with its parents, there are three possibilities in respect to the resemblance: first, a perfect combination of the qualities of both parents; second, a preponderance of the qualities of one or the other parent; third, none of the characters of either parent. In the first case, the offspring will represent a blending of the qualities of two parents in such a way that each individual character in the offspring is the sum of what it was in the two parents. This perfect balancing is, however, seldom encountered in practice. It is most nearly approached in animals that are the offspring of parents that closely resemble each other and have inherited their qualities from their ancestors. In other words, it is most frequently seen in pure-bred animals that are closely alike, and is often spoken of as *breeding true*. The condition in which the offspring resemble one parent more than the other is perhaps most common of the three mentioned. Certain individuals possess a power of transmitting their own characters to their offspring and overcoming those of the other parent. This is the quality known as prepotency, which has already been explained.

INBREEDING

53. The term **inbreeding,** or **incestuous breeding,** is generally used to describe the practice of mating together animals that come within certain degrees of blood relationship, as, for example, mating a sire to one of his female offspring or a dam to one of her male offspring, or a male to his full sister. By some breeders the term **in-and-in breeding**

is used to signify the same operation, but by others it is applied only to a repetition of the operation throughout a number of generations. **Close breeding** and **line breeding** are terms that signify the mating together of more or less closely related animals, but not animals so closely related as to constitute inbreeding. For example, a breeder may, starting with only two animals, a male and a female, establish a small herd by inbreeding. If, now, he avoids mating sires and dams to their offspring and brother to sister, but continues to interbreed the herd, he is then practicing close breeding, or line breeding.

54. There are probably no practical breeding problems that have been more discussed than the advisability or inadvisability of inbreeding, and the subject may still be considered as unsettled. It is generally recognized that the practice of inbreeding tends to strengthen general heredity and to make more certain the transmission of the characters possessed in common by the related animals, even increasing or accentuating them. On the other hand, weakened constitutions, dwarfed size, and lessened fecundity have been frequently noticed to follow in the practice of inbreeding. Many breeders have not hesitated to state that the practice of inbreeding will in itself bring about these undesirable results, but there is considerable question as to this being an invariable rule. The modern ideas of the inadvisability of inbreeding are undoubtedly founded on the prohibition of marriages between certain related persons by Biblical authority, but it is of importance to note that not all of these are blood relatives. Some opponents of inbreeding have pointed out the elaborate provisions found in some blossoms to prevent self-fertilization in support of their position. But here again the evidence is not conclusive, for there are many blossoms in which the provisions of nature prevent cross-fertilization, so that these blossoms are practically always self-fertilized, which is equivalent to inbreeding in animals.

A justification of inbreeding is found in the life of wild animals similar to most of our domestic animals. For

example, in the case of the buffalo, the wild horse, and some species of wild sheep, goats, and deer, the ordinary life of a herd or flock is almost sure to result in inbreeding to a fairly close degree. Such flocks are dominated by a single male, who rigorously excludes all other males from its vicinity and becomes the sire of all the young born. The young females remain with the herd and reach maturity during the life of their sire, and are almost certain to bear offspring by him, thus giving rise to inbreeding. When, through the decreasing vigor of such a sire, he is deposed, it is quite likely to be by one of his own sons, which will take his place. This new sire, coming to the head of the herd, finds in it a considerable number of his sisters, and as a matter of course mates with them, thus bringing about further inbreeding.

There is no doubt but that at the present time a large majority of practical breeders look on the evils likely to follow inbreeding as greater than the benefits that may be derived from it, and consequently they hesitate to practice it. There can be no question, however, that skilful inbreeding is one of the most useful methods in the hands of the breeder in strengthening the power of inheritance and bringing about a greater degree of uniformity and improvement.

55. Inbreeding as a practical method of improving domestic animals did not come into use until after the middle of the 18th century. Previous to that time all improvement in domestic animals was sought by *crossing;* that is, constant infusion of new blood. One man is credited with the introduction of the practice of inbreeding. This man was Robert Bakewell, an English tenant farmer, born in 1726, and living at Dishley, Leicestershire, England. Although Bakewell left few, if any, written records of his practice, it is known that he selected animals for mating wholly on the basis of the degree to which they possessed the desired characters and without regard to relationship. He often mated together animals very closely related and continued this practice for many years until he greatly improved all the animals that he handled on his farm, more particularly the Dishley or

Improved Leicester sheep, the English cart horse, and the Longhorn cattle. Since Bakewell's time, inbreeding has been successfully used by a large number of breeders, and it has been an important factor in the improvement of nearly all of our modern breeds of domestic animals.

56. Many illustrious instances of successful inbreeding might be cited, but a few will suffice to show what has been accomplished. Perhaps no men were more successful in the practice of inbreeding than Charles Colling and Thomas Bates, early improvers of Shorthorn cattle. Pedigrees of many animals bred by them show the closest kind of inbreeding. Favorite, one of the most famous of the early Shorthorn bulls, was an inbred animal, resulting from the mating together of Bolingbroke and Phœnix, themselves nearly full brother and sister, as shown by the pedigree illustrated in Fig. 9.

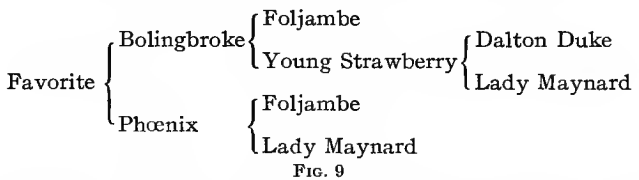


FIG. 9

Favorite, a vigorous, prepotent, and long-lived animal, was bred on his own offspring time without number, in one case, tradition says, for six generations, culminating in the production of the famous cow Clarissa, as shown in the diagram of her pedigree in Fig. 10.

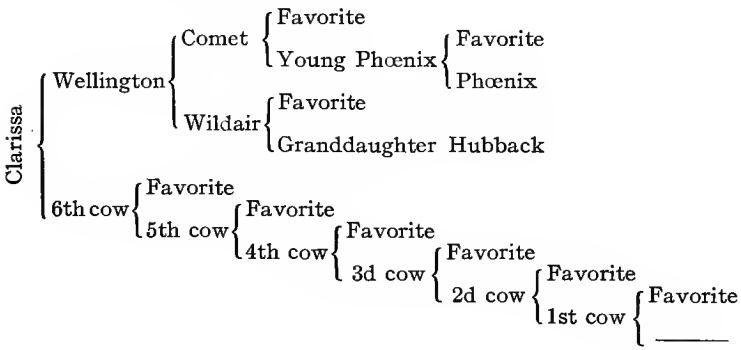


FIG. 10

But in no case was close inbreeding carried to a greater extent than in the production of the full brothers Comet and North Star. In this case, the inbred bull Favorite was bred to his dam, Phœnix, to produce Young Phœnix, who, in turn, being bred to her sire, produced the bulls Comet and North Star, as shown in the diagram, Fig. 11.

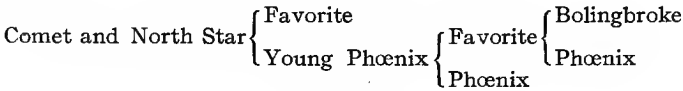


FIG. 11

The two bulls, Comet and North Star, further illustrate the principles of selection that must accompany successful inbreeding. Comet undoubtedly stands second only to Favorite in desirable individual qualities, in fecundity, and in prepotency. North Star, on the other hand, seems to have had no power to impress his qualities, and left very few descendants. That Colling had the sagacity to select Favorite and to discard North Star illustrates the sort of rigid selection that must always accompany inbreeding.

No family of animals was ever more famous than the Duchess Shorthorns developed by Thomas Bates on foundations laid by Charles Colling. The foundations of the family in Bates' hands were Duchess 1st and Ketton 1st. The latter was a full brother of the dam of Duchess 1st, and it will

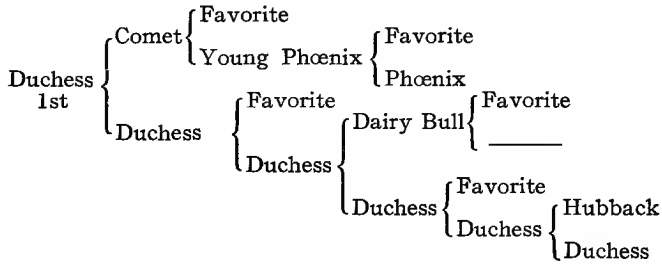


FIG. 12

be seen from Fig. 12 that Duchess 1st was a closely inbred animal. From this foundation, with practically no infusion of other blood, Bates bred more than one hundred animals,

practically all of which were excellent individuals in themselves and had the power to transmit their qualities to their offspring.

Other instances of successful inbreeding are shown in Figs. 13 and 14, which are diagrams of the pedigrees of animals

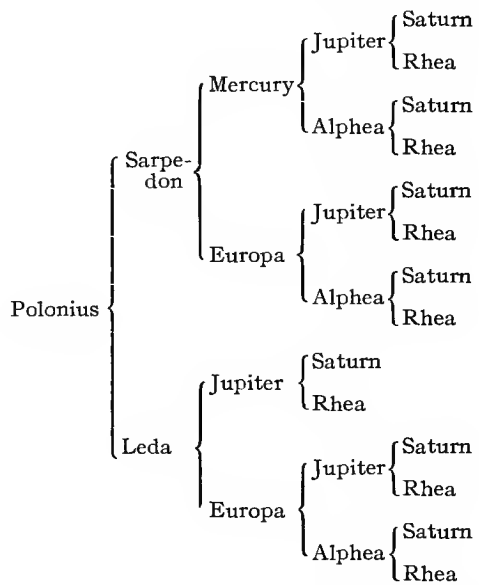


FIG. 13

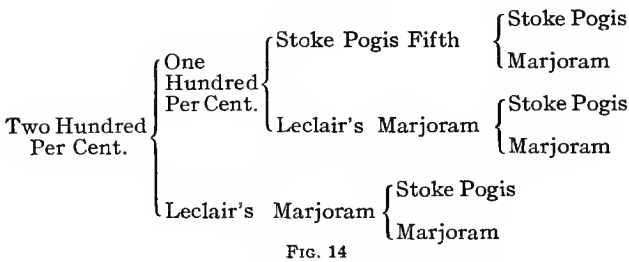


FIG. 14

belonging to the Alphea and the St. Lambert families of Jersey cattle.

57. These illustrations of successful inbreeding make clear the principle that rigid selection must accompany inbreeding,

and that when the selection is rigid, the degree of relationship has little to do with success or failure. Breeders who propose to practice inbreeding must disregard relationship entirely and rigidly exclude any individuals that show lack of constitution, fecundity, or size. Those who are inclined to urge the dangers of inbreeding are often equally inclined to urge the benefits of crossing, and history shows that it was through introducing fresh blood that improvement was usually sought by early breeders. There is no question but that the introduction of a fresh strain of blood tends to increase constitution and fecundity, but the fresh blood so introduced must come from a common source not too far back for, as has already been shown, violent crossing—that is, mating together very unlike breeds—is liable to give rise to reversion. With care and skill in selection, a new desirable character may be introduced into a breed as a result of a cross, but it is not an easy thing to do, and comparatively few breeds of domestic animals have been formed by the direct crossing of well-established separate breeds. Very many crosses are undoubtedly made with the hope that the desirable qualities of the parents may be combined in the offspring to the exclusion of the undesirable qualities. That such hopes so frequently result in failure is not to be wondered at when it is called to mind that the chances are just as favorable for the combination of undesirable qualities to the exclusion of desirable ones. To use a common illustration, Jerseys are often crossed with Holsteins with the hope that the offspring may give as much milk as the Holstein and that the milk will contain as much fat as that of the Jersey. The exact opposite is just as likely to occur.

There is one condition under which crossing may result in advantage. Very many breeds nick, or blend, well together in the first generation, certain useful characters in either breed being dominant. In this way it is often easier to produce a more satisfactory and uniform type of market stock than it is to keep strictly within the limits of the breed or to depend on grade animals.

BREEDING TO POINTS AND IMPROVEMENT OF BREEDS

58. In all breeds of animals there are particular structures, colors, forms, etc. that are considered to be characteristic of the breed. For example, in the Dorset sheep, a white face, large nostrils, small horns curving forwards, and other definite body structures must be possessed by a typical animal of the breed. These specific characters are known as **points,** and by their presence or absence the breeder judges of the excellence or deficiency of an animal as a representative of the breed. By training, environment, inbreeding, and selection the form may be modified and the relative value of the various points or characters changed so as better to suit the use or the fancy of the breeder. All Dorset sheep, for example, do not possess proper development of the essential points of the breed. A given flock may depart from the standard by the presence of a considerable number of individuals having spotted faces and horns curving outwards instead of forwards. But by some or all of the breeding operations mentioned it is possible to modify these points and bring the flock to a condition in which it will approach the ideal form very closely. The operation by which this is brought about is termed **breeding to points.** It is possible that by a continuation of the process, the breeder can develop the points to the extent that they will excel those of the animals that were considered typical of the breed. Such a procedure is known as **improvement of breeds.**

CASTRATION

59. In the course of breeding operations, it is customary to select from the total number of males produced those that are of sufficient merit for use as sires. These sires may be used by the breeder himself, or he may sell them to other breeders. The remaining males—those that are considered as inferior or unsuitable for use as sires—are usually **castrated,**

that is, they are deprived of the power of reproduction by the removal of the germ-bearing organs, which, in this case, are the testicles. There are several reasons why this operation is desirable. The meat of male animals that is used for human food is improved in quality if the animals are castrated when young; horses that have been castrated are more easily handled and more applicable to various kinds of work than are stallions; castrated males can be allowed to range freely with other stock and the energy that in the uncastrated male would go to the development and use of the sexual organs may be directed to other and more profitable ends.

To some extent these advantages will also apply to the castration of females, which operation consists in the removal of the ovaries and is commonly known as **spaying.** In general, however, the spaying of females, being a more difficult operation than the castration of males and the advantages not so marked, is not so commonly performed.

The details of both of the preceding operations will vary slightly with the different groups of domestic animals; hence, specific directions in regard to them will be reserved for consideration in connection with each particular group. Among horses, a castrated male is known as a *gelding;* among cattle, as a *steer* or *stag;* among sheep, as a *wether;* among pigs, as a *barrow.* The castrated female of the same groups is usually referred to simply as a spayed mare, spayed cow, etc.

DETERMINATION OF SEX

60. In the breeding of domestic animals, the sex of the offspring produced is usually an important consideration. Under some conditions, male offspring are greatly preferred and under other conditions females are desired. In either case, a preponderance of the desired sex means an increased profit for the breeder. This being true, it is but natural that breeders should have sought from the earliest times to discover a means by which the sex of offspring could be controlled.

Determination of sex is the term commonly used to designate this problem. Notwithstanding the effort that has been made to accomplish the desired result, no method has been found by which either sex or even a majority of either sex can be produced at will. On the contrary, it has been proved that, as a rule, taking into account a sufficient number of animals or a sufficient length of time, practically equal numbers of both sexes are produced. Frequently, one sex will predominate for a limited time or in the case of a few animals, but the general rule holds, nevertheless.

With the great amount of attention and study that has been given to the problem of the determination of sex, it is not strange that a large number of so-called rules have been brought forward as a means of controlling the sex. Some of these have enabled unscrupulous persons to reap considerable financial reward from the ignorant and unwary, but none of these rules have stood the test of actual practice. A brief review of some of the more important of these rules or theories may be of interest to the student of breeding.

Since the essential organs of reproduction—that is, the ovaries and testicles—are double, it is quite natural that the idea should have arisen that one organ is concerned with the production of one sex and the other with the other sex, but this idea was long ago disproved by observation and by actual experiment.

The relative vigor of the parents, particularly the sexual vigor, has been supposed to control the sex of offspring, but curiously enough this idea has been applied in both ways. It has been claimed by some that the most vigorous parent begets a larger percentage of offspring of its own sex and by others that it begets a larger percentage of the opposite sex, and examples have been produced to support both claims. This being true, it is evident that this theory of sex determination is untenable.

A theory that has been very widely held is that sex is determined by the degree of maturity of the ovum at the moment of fertilization, and that the earlier the ovum is fertilized the more likely the resulting offspring is to be a

female. The application of this rule was to have the male serve the female as soon as the period of heat appeared if females were desired, and delay service until the latest possible period if males were desired. This theory has had a wide circulation, but it has long since been abandoned so far as any definite results secured from its application are concerned.

The rule that has had the widest notoriety has been applied only to domestic cattle. It is the so-called alternate heat rule, and is based on the idea that the alternate ova, as they mature, will produce, if carried to full development, offspring of opposite sexes. For example, if a cow has produced a male calf and it is desired to secure a female the next time, she must be served on the first, third, or any odd number of heats. If a male is desired, it would be secured from service on the second, fourth, or any even number of heats. If the last offspring had been a female, males would be produced from service on the first, third, fifth, etc. heats, and females from service on the even numbers. Many breeders have tried to carry out this rule, but failures from it have been more numerous than successes.

BREEDING RECORDS AND STANDARDS

BREEDING RECORDS

61. One of the important considerations in breeding operations is that of keeping careful records of individual animals. This applies not only to the work of the individual breeder, but also, and perhaps with more force, to the development of the breed as a whole. In the selection and mating of animals, the individual breeder is greatly aided by a knowledge of their ancestry. Moreover, the value of those he sells to other livestock men for breeding purposes will, to a very large extent, be determined by the same factor. The permanence of breeds, as such, depends to a large extent on the maintenance of an accurate and detailed record of the

individuals therein. It is very evident that, in order to meet the preceding requirements, methods by which authentic and systematic record may be kept are essential. The methods by which individual breeders may keep their records will be discussed in detail under the different groups, but mention will be made here of the system of livestock records by which important facts pertaining to the different breeds are recorded.

62. For the purpose of maintaining records and the accomplishment of other ends advantageous to their respective interests, breeders of a given class of animals usually organize what is known as a breeders' association, a record association, or pedigree-record association. Various names, derived usually from the name of the particular breed, are given to these bodies, as, for example, the American Shorthorn Breeders' Association, the National Delaine Merino Breeders' Association, the Standard Poland-China Record Association, etc. Each association usually compiles and publishes an annual volume containing records of the ancestry of animals that are accepted for registry during a given period preceding the issuance of the book. Record books relating to horses are usually known as **stud books;** cattle record books, as **herd books;** sheep record books, as **flock,** or **record, books;** and swine record books, simply as **record books,** although in the case of the last two classes there is considerable variation in the terms used by different associations.

At the time of the organization of an association an effort is usually made to collect all important existing records extending back to the formation of the breed. To these are added the names of animals of merit from succeeding generations. The process of enrolling an individual on the records is known as *registration*, and is regulated by certain rules or requirements of the association. For example, it may be stipulated that an animal possessing seven-eighths pure blood of the breed is eligible to registry. However, most associations will accept no animal to registry that does not show pure-bred parents; that is, both the sire and the dam must be registered animals in order to admit the offspring to registry.

Form 1

American Short-Horn Breeders' Association

Certified Copy of Pedigree Accepted for Entry in the American Short-Horn Herd Book

Name.....

Color..... *Calved*.....

Bred by..... *P. O.*..... *State*.....

Owned by..... *P. O.*..... *State*.....

		Sire's Number
*(Vol. p.)	*Got by*.....	
Out of.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	
.....	*by*.....	

This is to Certify, *That the above pedigree has been accepted for record in Vol.*.....

In Testimony Whereof, *I have affixed the seal of the Association.*

Chicago, Ill...... *A. D. 1911*

AMERICAN SHORT-HORN BREEDERS' ASSOCIATION

SECRETARY.

Clerk.....

[OVER]

FIG. 15

63. On the admission of an animal to registry, the owner is usually furnished with a certificate of registration, in which is stated the name of the sire and dam of the animal, together with other essential facts regarding date of birth, sex, color, owner, etc. A name is usually given to the animal by the owner, and to this name the association usually adds a number, the two usually being necessary to its complete designation. Another work of the association consists in furnishing a pedigree on application. A *pedigree* is a document recording the ancestry of a given animal for a variable number of generations. Few pedigrees go farther back than eight or ten generations. Pedigrees that go back to the ancestors that were first admitted to the breed record are referred to as *complete pedigrees*.

Two general forms of pedigrees are in common use. One form is by means of a blank similar to the one shown in Fig. 15. Spaces are provided for recording the name and other facts as to color, age, breeder and owner, of the animal whose pedigree is being written. Following these are spaces for recording the name of the sire, the name of the dam and her sire, the name of the second dam and her sire, the third dam and her sire, etc. In this form of pedigree no record is given of the parentage of the sires, and in this respect it is somewhat incomplete. The other form of pedigree gives the name and number of both the sire and the dam and the sire and the dam of each of these, and in this way traces the record back for a variable number of generations. A pedigree of this form is customarily written in the form of a diagram, illustrations of which are shown in Figs. 9 to 14, inclusive.

On account of the differences that exist in the matters of registration and pedigree among the different breeds, a detailed description will be reserved for discussion in the consideration of those groups.

STANDARD OF EXCELLENCE

64. The application of the foregoing principles of breeding must be along a definite line in order to accomplish results. Unless the breeder has a goal toward which he is working, no material improvement can be brought about. To meet this condition most breeders' associations make a statement of what is considered the ideal animal for their breeds. This statement is known as a **standard of excellence,** and usually consists of a printed enumeration of the qualities that go to make up an ideal animal of the breed, although in some cases no printed standard exists, the ideal being carried in the minds of the breeders.

Standards of excellence are of two kinds. The first relates to the characters of an animal that may be determined by an inspection or an examination. Form, color, size, etc. are qualities that are taken into consideration. *A score card* similar to that of the accompanying score card for Berkshire swine is one form of such standard. A value is given to each important point or character; for example, a value of 3 points out of the total 100 is given to color. In comparing an individual with the ideal, an estimate is made as to how nearly the color of the individual approaches the ideal and an allowance is made on the score card accordingly. As an illustration, if the color is considered good, 2 points may be allowed; if it is only fair 1 point may be allowed. Other items on the score card are taken up in the same way, and the sum of the points allowed is determined. This is referred to as the **score** of the animal, and the operation of determining it is called **scoring,** or **judging.** Some breeding associations issue for the guidance of their members what is known as a *standard scale of points.* As a rule, the latter differs from a score card only in the omission of blanks for recording the score of a particular animal.

In addition to the score card, there is another form of standard of excellence based not on external appearances but on performance. In dairy cattle, for example, individual cows that are able to yield above a certain quantity of milk

SCORE CARD FOR BERKSHIRE SWINE

STANDARD OF EXCELLENCE ADOPTED BY THE AMERICAN BERKSHIRE ASSOCIATION

	PERFECT SCORE	JUDGE'S SCORE
COLOR—Black, white feet, face, and tip of tail, but skin and hair occasionally showing tinge of bronze or copper color. An occasional splash of white not objectionable; lack of either of white points admissible	3	
FACE AND SNOUT—Face well dished and broad between eyes. Snout short and broad	7	
EYES—Prominent, clean, clear, large, dark hazel or gray	2	
EARS—Medium size, setting well apart, carried fairly erect, inclining forward, especially with age	3	
JOWL—Full, firm, not flabby or hanging too low, running back well on neck	3	
NECK—Full, short and slightly arched; broad on top; well connected with shoulder	3	
HAIR—Fine, straight, smooth, lying close to and covering the body well. Free from bristles	3	
SKIN—Smooth and mellow	3	
CHEST—Deep, full and wide, with good heart girth	6	
SHOULDER—Smooth and even on top and in line with side	6	
SIDE—Deep, smooth, well let down; straight side and bottom lines	6	
BACK—Broad, full, strong, level or slightly arched; ribs well sprung	10	
FLANK—Extending well back and low down on leg, making nearly a straight line with lower part of side	5	
LOIN—Full, wide and well covered with flesh	6	
HAM—Deep, wide, thick and firm, extending well up on back and holding thickness well down to hock	10	
TAIL—Well up on line with back; neither too fine, short nor tapering	2	
LEGS AND FEET—Straight and strong, set wide apart, short in pastern, with hoofs nearly erect, capable of carrying great weight	10	
SIZE—Size all that is possible without loss of quality or symmetry, with good length. Weight in good condition, boars at 12 months, 350 to 450 pounds; at 24 months, 500 to 700 pounds; sows at 12 months, 350 to 400 pounds; at 24 months, 500 to 700 pounds	6	
APPEARANCE AND CHARACTER—Vigorous, attractive, of good disposition, firm and easy movement	6	
Total	100	

for a prescribed time are admitted to what is known as **advanced registry,** which constitutes the second kind of standard of excellence. Other classes of animals are admitted to advanced registry when evidence of superior excellence along other lines is presented.

DAIRY BARNS AND EQUIPMENT

DAIRY BARNS

GENERAL REQUIREMENTS

1. The chief purpose of a dairy barn is to shelter the dairy herd. Inasmuch as the dairy cow is a highly specialized animal and is, as a general rule, thin in flesh, particularly during the lactation period, she is perhaps more susceptible to cold than any other domestic animal. Therefore, if she is to produce a maximum quantity of milk, it is imperative that she be sheltered from inclement weather.

Obviously, the problem of providing shelter for dairy herds will vary considerably, depending on the climate of the region in which the dairy is located. Thus, a barn that is suitable as a shelter in southern latitudes will not as a rule answer the purpose in Canada and the northern part of the United States, and vice versa. Of course, the idea of shelter is not the only thing to be considered in connection with the planning and building of dairy barns. The health of the animals demands attention, and considerable thought must be given to the equipment and its arrangement, in order that the work of caring for the animals can be done without unnecessary waste of time and energy.

2. An important requirement in connection with dairy barns is an adequate system of ventilation. Of course, all domestic animals require fresh air and are likely to suffer if they are confined in a barn in which no provision is made for

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

ventilation, but dairy cows seem to be especially susceptible to disorders that result from insufficient ventilation. It has been determined by experiment that a cow requires about 60 cubic feet of fresh air per minute; an adequate system of barn ventilation, therefore, must provide for the admission of a sufficient quantity of fresh air to meet this requirement and also for the removal of a similar quantity of foul air. It is essential, though, that the fresh air be admitted in such a manner as to avoid direct drafts on the cows and also that vitiated air—not the fresh air—be removed from the barn.

3. Means of providing light and heat demand attention in planning a dairy barn. A barn with a dark interior is objectionable for several reasons, one of the most important of which is the fact that such a barn is very likely to be unsanitary. Other things being equal, disease germs thrive best in dark enclosures. Moreover, dirt and filth are likely to accumulate and escape notice in barns that are not adequately lighted. The work of feeding, cleaning, and milking the cows, the removing of manure, and other routine operations about a barn can be much more easily and quickly accomplished in a well-lighted interior than in one that is dark and gloomy.

Light in a dairy barn is supplied by windows, which should be sufficient in number to insure a well-lighted interior. Windows so placed as to admit direct sunlight will also aid materially in keeping the interior of the barn at the proper temperature in winter. Therefore, in planning a dairy barn it is advisable to include plenty of windows, particularly on the sides that will be exposed to the sun during some part of the day. A rule sometimes followed in this connection is to provide 4 square feet of window space for each cow of average size, but at best this is only an approximation that may be modified as conditions warrant.

A barn built according to the general plan outlined in Fig. 1 and placed so that the main axis indicated by the line *a b* extends southeast by northwest—the compass shown in the illustration suggests the degree of inclination of this line to the true north and south line—is favorable, in northern latitudes,

to the admission of a maximum quantity of sunlight. However, if the slope of the ground on which a barn is to be built is toward the southeast, much excavating at one end and high foundation walls at the other end may be required. Of course, the plan suggested may not always be feasible, in which cases it will be necessary to devise another one that takes into consideration the local conditions.

If electric current is available, the installation of electric lights in a dairy barn will greatly facilitate the work of feeding and milking during winter months. Such a system of lighting is not only more efficient and convenient than oil lamps and lanterns, but also lessens the danger of fire.

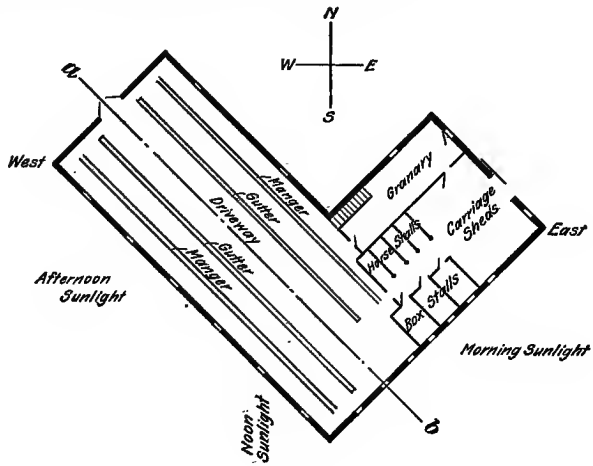


FIG. 1

The interior of a dairy barn will usually be kept sufficiently warm by the heat that is given off by the animals and by the sunshine that enters through the windows. A uniform temperature of from 55° to 60° F. is about right for a dairy cow, and if a barn is properly constructed the temperature of its interior will seldom fall much below the lowest figure mentioned. Dairy barns are sometimes equipped with steam-heating plants. In exceptional cases, it is possible that the outlay involved in such an equipment is justified; these cases are, however, so unusual that it is unnecessary to consider them here.

4. The requirements thus far considered have to do mostly with the health and comfort of the dairy herd. Next in importance to these requirements in planning a dairy barn is the interior arrangement. It should be the aim to reduce to the lowest possible limit the labor required to take care of the herd. A poorly planned barn may require many unnecessary steps and much unnecessary labor every day, and when it is considered that this goes on practically every day in the year, the aggregate waste becomes enormous. In connection with the interior arrangement, the storage of feed, the water supply, and the arrangement of stalls are important items. Besides these, there are many labor-saving devices, such as milk, feed, and manure carriers, mangers, water troughs, etc., that should be given attention. A detailed discussion of these devices appears in subsequent pages.

5. Good authorities advise against the storing of hay and grain feed directly over the compartment occupied by cows; nevertheless, most dairy barns have a second floor that serves as a haymow and storage room for feed. This arrangement is considered objectionable for the reason that dirt, dust, chaff, etc. are likely to sift through the floor into the compartment occupied by the cows, and also because in barns so constructed there is a tendency to make the ceiling of the first floor too low. If the latter objection is guarded against and the ceiling over the cows is made dust-tight, it is permissible to store hay and concentrated feeds on the floor above the cows and provide chutes through which these materials may be conducted, as desired, to a feed room on the first floor. This arrangement obviates the necessity of giving up valuable space on the barn floor for storage. If the barn is to be rectangular in form, a silo may be placed at almost any point that will be convenient. Round and polygonal barns are usually built with a silo in the center, which is perhaps the most satisfactory arrangement from the standpoint of convenience and economy. The chutes leading from the feed room, the silo, and the hay-storage room should be so placed that the distribution of feed can be made with the least expenditure of time and energy.

6. A water supply from an elevated tank or reservoir is a convenience that should be installed when practicable. Such a system is not only useful in watering cows, but also makes it possible to flush the gutters in the barn and to wash down the walls, ceiling, and fixtures with a jet of water delivered through a hose. Various methods of supplying drinking water to cows are employed. Individual drinking troughs are often provided, but many dairymen object to them because each trough must be cleaned before watering the animals and emptied after watering them. A more satisfactory plan is to provide a continuous trough extending along the entire length of a row of stanchions. At watering time, an attendant with broom can easily and quickly remove the dirt, hay, and litter from such a trough. Water is drawn into a trough of this kind from a penstock, and when the cows have finished drinking the trough is drained by opening a vent at one end. A continuous trough may also be used as a manger for silage and concentrated feed, but, as pointed out elsewhere, this arrangement is somewhat objectionable.

7. The arrangement of stalls in a dairy barn has an important bearing on its convenience. Most barns have at least two rows of stalls, and experienced dairymen are generally agreed that the most desirable plan is to place these stalls so that the cows will face away from one another when standing in them. If such an arrangement is followed, it will be possible to have a driveway between the gutters behind the stalls. Such a driveway, provided it is made wide enough to accommodate a cart, a wagon, or a manure spreader, will greatly simplify the work of cleaning out the gutters. It will also provide a convenient place for weighing milk and distributing bedding to the stalls. Another point of favor in this plan is that cows may enter the barn through a door in the end and pass along the alley between the gutters to their respective stalls; whereas, if the cows are made to face toward each other, either two entrances must be provided or the herd must be divided after it enters the barn. Moreover, in the latter plan, the passageways behind the stalls will usually be close to the walls,

which will be splashed with urine and soiled with manure as the cows enter and leave the barn. If the cows face away from one another, this difficulty is obviated. Some dairymen claim that in barns in which the stalls are placed so that animals face away from one another, the same number of cows may be cared for with one-half the work required in a barn in which the stalls are placed so that the animals face one another.

8. It is desirable from a sanitary standpoint to remove milk from an enclosure occupied by cows as soon as it is drawn. A good idea is to build a milk room in the barn; but if this is done, it is imperative that this room be separated from the remainder of the barn by walls that will exclude barn odors. For the same reason, the entrance to the milk room should be from the exterior—not from the barn. Some of the barn plans shown later illustrate how this may be accomplished without serious inconvenience.

LOCATION AND CONSTRUCTION OF DAIRY BARNS

DAIRY-BARN SITES

9. In the selection of a site for a dairy barn, certain general requirements should be taken into consideration. It is likely that in most cases one or more of them will have to be sacrificed, to some extent at least; nevertheless, it is advisable to bear them in mind. The more important of these requirements are the elevation and exposure of the site, the nature of the soil, the proximity of the site to other buildings, and the convenience of the site to water supply and pastures.

10. Elevation and Exposure of Site.—In general, a site that is somewhat higher than the surrounding ground is preferable for dairy barns, for the reason that such a location is favorable to good natural drainage. An elevation that will expose a barn to cold winds, however, is objectionable in cold climates. Rather than select such a site, it will, in most cases, be advisable to choose a lower and more protected location and provide surface drains and underdrains to carry off sur-

plus water. So far as drainage is concerned, almost any site can be made satisfactory by the proper arrangement of these details. Steep hillsides should be avoided if possible, on account of extra work involved in hauling loads to and from the barn, and also because of the likelihood of such hillsides becoming slippery when muddy or covered with ice.

If possible, the exposure of the site should be toward the south or southeast, rather than toward the southwest. A barn plan that extends the main axis of the structure somewhat to the southeast as shown in Fig. 1 is good, because in this way the greatest possible amount of sunlight is admitted to its interior. If the exposure is such that there is no natural windbreak to protect the barn from both north and west winds, it is advisable to plant trees to serve that purpose.

11. Soils for Dairy-Barn Sites.—Almost any soil is suitable for a dairy-barn site, except one that contains an excessive quantity of vegetable matter or refuse. A foundation placed in such a soil is likely to be unstable, and as a result a building erected on it may be thrown out of plumb by unequal settling. A further objection is that soil of this nature is likely to be mucky in wet weather, when the decaying organic matter contained in it may give rise to unsanitary conditions.

Probably the most desirable soil for a dairy-barn site is a sandy or gravelly loam with a subsoil of the same nature. Soils of this kind are favorable to good drainage; also the filtering action of the sand and gravel tends to purify water that passes through it, thus avoiding the contamination of wells and streams into which it may find its way.

12. Proximity of Site to Other Buildings.—From the standpoint of convenience, it is usually desirable to place a dairy barn close to other farm buildings; but there are serious objections to grouping such buildings too close together. A fire is liable to destroy all buildings if they are grouped, whereas only a single structure might be lost if the barns are separated from one another. Farm buildings grouped together are also favorable to the spread of contagious diseases and insect parasites. Fireproof construction and an adequate supply of water

under pressure may overcome the first mentioned objection to some extent, but as a general rule it will probably be best not to build a dairy barn very near other livestock quarters.

13. Convenience of Site to Water Supply and Pastures. Not infrequently the location of a well or a spring is a factor in selecting a site for a dairy barn. It is, of course, an advantage to have a water supply close to the barn, but unless the site that permits this is acceptable from other standpoints it will usually be advisable to pipe the water to the barn rather than build the barn in an undesirable place merely for the sake of having it close to the water supply. There are several methods by which water may be raised to a higher level in case a well or a spring is lower than the site on which a barn is erected. Among these may be mentioned the hydraulic ram, a pump driven by a windmill, a gasoline engine, or a hot-air engine.

If a permanent pasture is available on the dairy farm, it may be advantageous to erect the barn for the cows conveniently near this enclosure. It is also well to choose, if possible, a site containing space that may be fenced off into small yards in which the cows may be turned for exercise in winter.

CONSTRUCTION OF DAIRY BARNS

14. Foundations.—The foundation of a dairy barn should rest either on firm soil at a point somewhat below the frost line, or on solid rock. Foundation walls are usually built from 8 to 24 inches thick, depending on the size of the barn they are to support, and it is customary to make the base of such a wall from 8 to 12 inches thicker than the upper part in order to spread the weight over a greater area. This style of construction is shown in the foundation for a small dairy barn illustrated in Fig. 2.

The materials commonly used for dairy-barn foundations are brick, stone, concrete, and cement building blocks. In Fig. 2, the foundation wall consists of brick resting on a concrete base. Of the four materials mentioned concrete is usually the least expensive.

Three methods of constructing concrete foundations are shown in Fig. 3. In the method shown in view (*a*), the walls

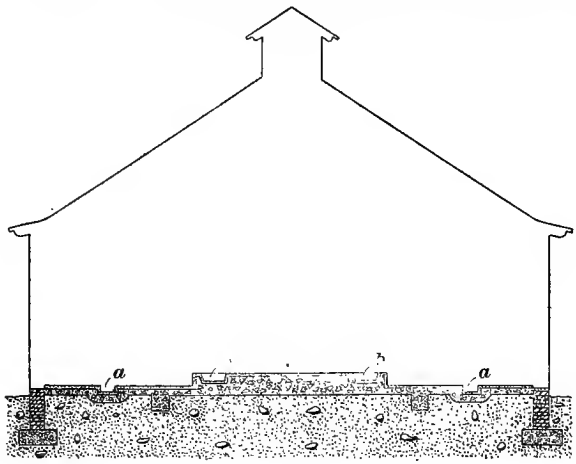


FIG. 2

of the excavation serve as the form for the concrete, which is simply poured into the trench. If the barn is to be built on a slope, it may be advisable to excavate as shown in view (*b*) and use a form of lumber for one side of the concrete wall. Dimensions of lumber suitable for making the forms are indicated in the illustration. In the method shown in view (*c*),

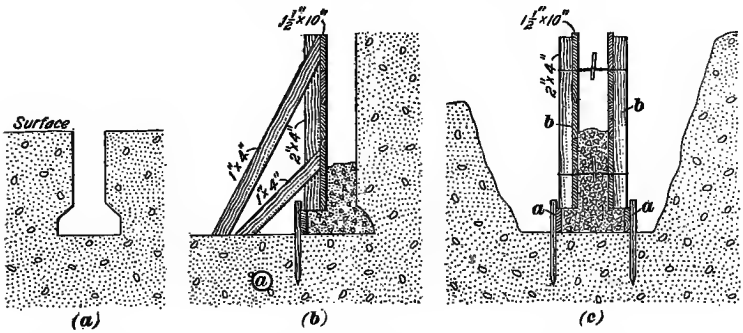


FIG. 3

lumber forms are employed for the entire foundation wall, *a* showing the form for the base and *b* the form for the wall

proper. The two sides of the form for the wall are prevented from spreading, when filled with concrete, by means of twisted wires, as shown. These wires are secured to the posts used to brace the planks of the wall form, and are allowed to remain in the concrete after the forms are removed, only the ends that project being cut off.

A concrete mixture that has been found satisfactory for barn foundations is made up of 1 part of Portland cement, 2 parts of clean, sharp sand, and 4 parts of crushed stone. Some builders use Portland cement and unscreened gravel in the proportion of 1 part of cement to 4 of gravel. A foundation of brick, stone, or building blocks may be preferable to a concrete foundation in localities where some one of these materials may be purchased cheaply. Of course, no forms are necessary in such cases, but some skill is required to build a wall out of these materials, particularly the first two, and it is usually advisable to employ a bricklayer or a mason to perform this work.

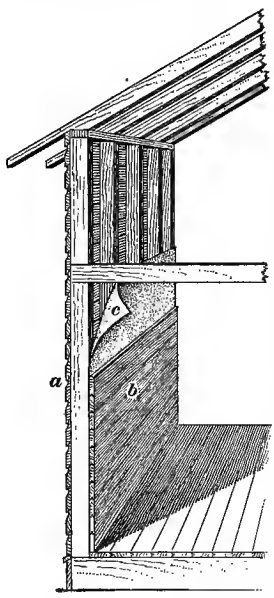


FIG. 4

15. Walls.—Double walls with an air space between the two parts are advisable for dairy barns in localities where it is necessary to protect cows from extremely cold weather. Such walls may be made of lumber, brick, stone, concrete, or cement building blocks. The details of construction are largely matters for experienced builders to decide, and as the conditions in each particular case must be taken into account only a few brief suggestions are offered here.

Figs. 4, 5, and 6 show three ways in which wooden walls for dairy barns may be constructed. The wall shown in Fig. 4 consists of studding, on the outside of which, as shown at *a*, is nailed drop siding and on the inside of which, as at *b*, is nailed

tongued-and-grooved oak flooring, a layer of heavy building paper *c* being placed between the oak flooring and the studding. The wall shown in Fig. 5 has the same interior construction as that shown in Fig. 4, except that the boards are put on vertically instead of horizontally. The exterior of this wall consists of barn boards. These are nailed on the studding vertically and the cracks between them are covered with battens. The wall in Fig. 6 has a somewhat more elaborate outside covering than either of the walls just mentioned. The studding, as shown, is covered with ship-lap lumber, and next to these boards is placed a layer of building paper, over which are laid shingles. If this style of construction is followed in building a dairy barn, building paper will not have to be used in forming the inside wall covering.

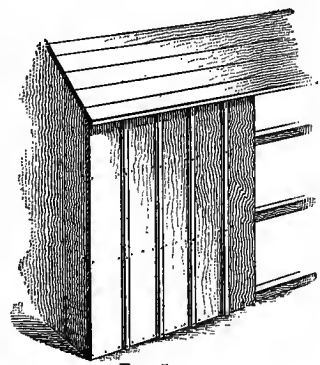


FIG. 5

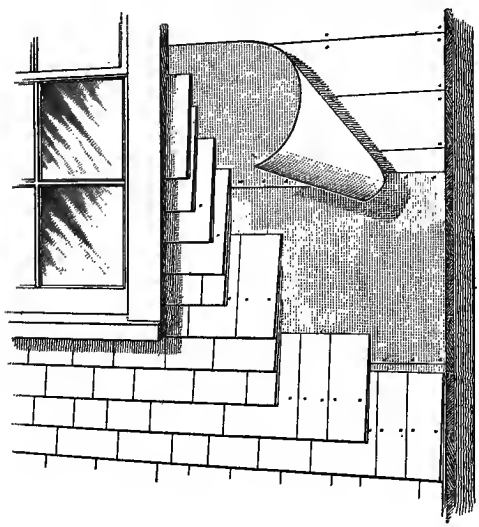


FIG. 6

Walls of brick, stone, or cement building blocks are durable and may be made attractive from an architectural standpoint. However, such walls are likely to be too expensive for average use unless some local condition makes the stone, brick, or cement blocks available at an unusually low price. Both brick and stone walls should be built with an air space in the center; building blocks are, as a rule, hollow, and thus provide for this detail.

Walls of concrete also are durable, and in many localities they can be made at a nominal expense. In Fig. 7 is shown a method of constructing a double wall of concrete. Two sets of boards *a* and *b* are so placed as to make a form consisting of two troughs into which concrete is poured. The outer boards *a* are held together by stays *c* fitted with iron rods *d*. By means of nuts on a threaded end of these rods, it is possible to clamp the stays to the wall below. The inner boards *b* are held in place by wedges *e* and cross-pieces *f*. Metal ties, one of which is shown at *j*, are used to tie the two sections of the double wall together. These ties are usually placed about 2 feet apart horizontally in each course of concrete work before it hardens. Notches are made in the inner boards of the form so that they will fit over the ties in the preceding course, as shown at *g*. Walls of this kind are usually reinforced by horizontal and vertical rods, as shown at *i*.

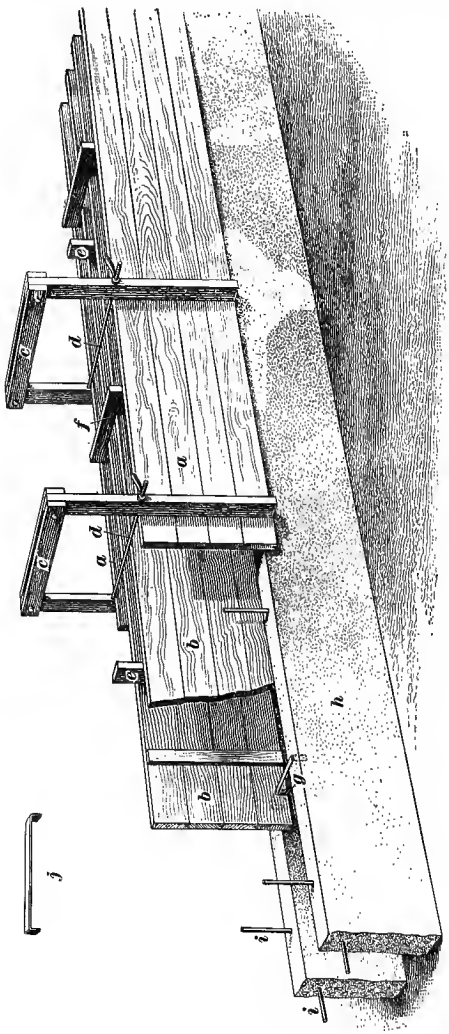


FIG. 7

Sometimes double walls made of concrete are built on the plan illustrated in Fig. 8, in which *a* shows a section of completed wall. In this case, the two parts of the wall are held together by means of concrete ties instead of metal ties as in the preceding plan. Such walls are also reinforced by horizontal and vertical rods, as shown at *b*. The outer forms used for this style of concrete wall consist simply of two sets of boards that are secured in practically the same manner as the outer boards in Fig. 7 and the inner forms are simply a series of box-like cores similar to the core shown at *c*.

16. Roofs.—Most of the common roofing materials, such as shingles, slate, tile, metal shingles, sheet iron, tin, and patent roofings, are suitable for forming the roofs of dairy barns. The

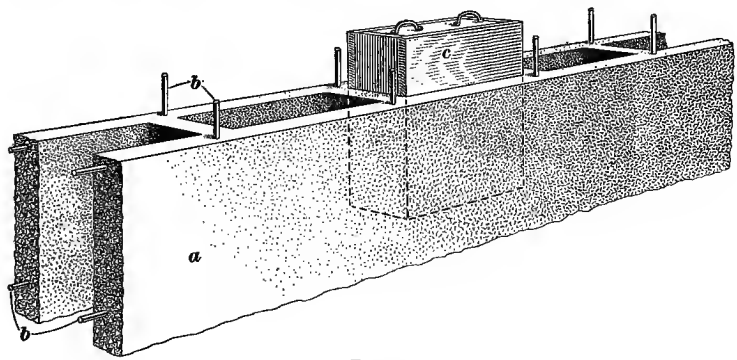


FIG. 8

style of barn that is to be built and the amount of money that is to be spent on it will, as a rule, govern the kind of material to use for roofing. Slate and tile roofs are extremely durable, but at the same time they are expensive. In the first place, the cost of the material itself is comparatively high; also, because a roof of this kind is much heavier than one of shingles or of sheet metal, it is necessary to use more or larger timbers to support it. Many kinds of patent roofings composed of paper, felt, or similar materials heavily coated with tar or asphalt, are on the market and are being extensively used.

A satisfactory roof may be made by covering the sheathing of a roof with heavy building paper, coating this paper with

coal tar, and the coal tar, in turn, with a layer of fine gravel. Best results are usually obtained by applying a second layer of tar and gravel. A roof of this kind will probably require a new coat of tar and gravel at intervals of 4 or 5 years, but it is practically indestructible if cared for in this way.

17. Floors.—Numerous materials can be used for the floors of dairy barns. Concrete is perhaps more extensively used than any other material. It has the advantage of being easily laid, and it is durable, smooth, and impervious to water. On the other hand, it is somewhat objectionable for the reason that it is cold and hard for cows to lie on and is likely to be slippery. Some dairymen provide a removable floor of planks for the cow stalls and slightly roughen or score the concrete surface in the alleys through which the cows walk. The section of plank flooring in each stall may be removed occasionally and the concrete floor cleaned. Such an arrangement combines the advantages and, to a large extent, obviates the disadvantages of an all-concrete floor. Some dairymen, however, prefer to use bricks as a flooring material in the alleys and stalls and concrete for the remainder of the floor.

In some dairy barns use is made of a clay floor, but as a rule such floors are not to be recommended. Bricks made of granulated cork and an asphalt binding material are said to be a very satisfactory flooring material for cow stalls. Wooden floors throughout the barn, although common, are objectionable. Not only do they absorb moisture, urine, etc., but they cannot be kept so clean as concrete floors and are not so durable. Floors of paving brick or stone blocks are sometimes laid in dairy barns, but in most cases concrete will be found cheaper and more satisfactory than either of these materials.

A concrete floor suitable for a dairy barn should have a foundation of about 18 inches of cinders or gravel. On this foundation should be laid about 5 inches of concrete mixture similar to that recommended for foundation walls, and over this mixture, after it has set, should be laid a 1-inch finishing coat made up of 1 part of Portland cement, 1 part of sand, and $1\frac{1}{2}$ parts of fine crushed stone. In laying a concrete floor

of this kind, it is customary to mold a gutter behind each row of stalls and a trench that may serve as a manger or a watering trough, or both, in front of each row of stanchions. A cross-sectional view of such a floor is illustrated in Fig. 2, in which *a* shows the gutters and *b* the mangers.

VENTILATION OF DAIRY BARNS

18. As was mentioned previously, an adequate system of ventilation is required in a dairy barn in order to provide the

FIG. 9

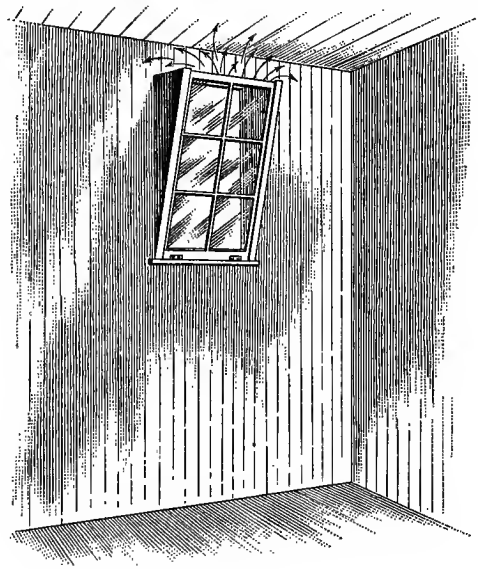


FIG. 10

cows confined in it with plenty of fresh air. In some cases this is accomplished by omitting glass from some of the window sashes and covering the opening with cloth. Numerous small inlets will be found preferable to a few large ones. This system of fresh-air admission, however, is not entirely satisfactory for the reason that it is not easy to control the ingress of air; also, during periods of low temperature and high winds, it is found difficult to keep the barn warm.

19. Two devices used extensively for admitting fresh air into dairy barns are illustrated in Figs. 9 and 10. Both of these permit of a better control of the incoming air than is possible with cloth-covered windows. The device in Fig. 9 consists merely of a strip of board about 6 inches wide and just long enough to fit the window opening. This strip is simply placed under the window sash, as shown. Fresh air enters the barn through the space thus formed between the upper and lower sashes, as indicated by the arrows. In Fig. 10, a single sash is hinged at the bottom and made to open in such a manner as to deflect the incoming current of air toward the ceiling. The arrangement by which this is accomplished is shown clearly in the illustration.

Foul-air outlets similar to those described later are generally used in connection with fresh-air inlets like those just described. In some barns no such outlets are provided, the pressure of incoming air being depended on to force the foul air out through the various openings, such as hay chutes, stairways, etc. Such a system of ventilation, however, is, at best, a makeshift.

20. King System of Ventilation.—Undoubtedly the most efficient system of ventilating for dairy barns is the **King system of ventilation,** which was devised by the late Prof. F. H. King. In the operation of this system, use is made of the principle that vitiated air in a barn, when cooled to approximately the temperature of the surrounding air is somewhat heavier than the latter and consequently tends to occupy a place near the floor of the barn.

The King system provides one or more flues that open on or near the floor and extend up to one or more openings in the roof. The pressure of the fresh air coming into the barn tends to force the foul air out through these flues and this movement is aided by a suction effect created by the passage of air-currents over the outside opening of the flue above the roof. The fresh-air inlets are so arranged that fresh air is taken in near the ground line on the exterior of the barn, carried upwards in the wall or in chutes inside the wall, and discharged into the barn near the ceiling.

21. In Fig. 11 is shown a cross-sectional view of a barn ventilated by the King system. The foul air flues are shown at *a*, and the fresh air inlets at *b*. It is estimated that one foul-air flue having an inside dimension of 2 ft. × 2 ft. will prove adequate for a barn housing twenty cows. In making this estimate it is assumed that the flue is nearly straight, or at least has no right-angled turns, and that it is so constructed as to be practically air-tight. Any considerable departure from these conditions will require additional outlet capacity, which may be provided either by increasing the size of the flue or by installing another flue. The foul-air flue should be made of good lumber and should be lined with building paper to prevent the leakage of air. Galvanized iron is sometimes used for such flues, but it is unsatisfactory in cold climates on account of the condensation of moisture on the iron in cold weather. This objection may, however, be overcome by covering the outside of the iron flue with building paper. The flue should extend from a point near the floor of the part of the barn occupied by the cows to a point somewhat above the highest point of the roof, in order that there may be an unobstructed sweep of air-currents across the outlet, thus insuring a good draft. The opening into the flue should be within a few inches of the level of the barn floor, and it is well to provide a second opening into the flue near the ceiling of the part of the barn occupied by cows. An opening of this kind is shown at *c*, in Fig. 11, and it is intended to provide a means of allowing warm air to escape

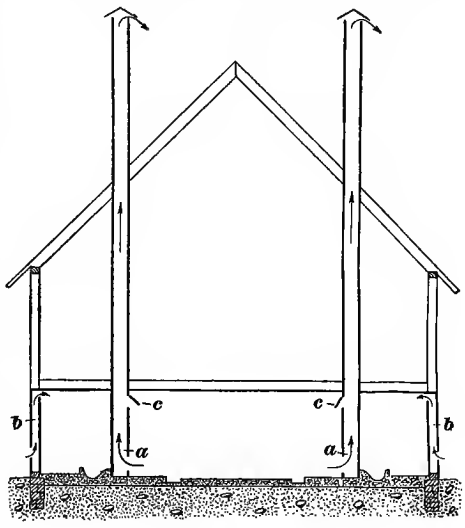


FIG. 11

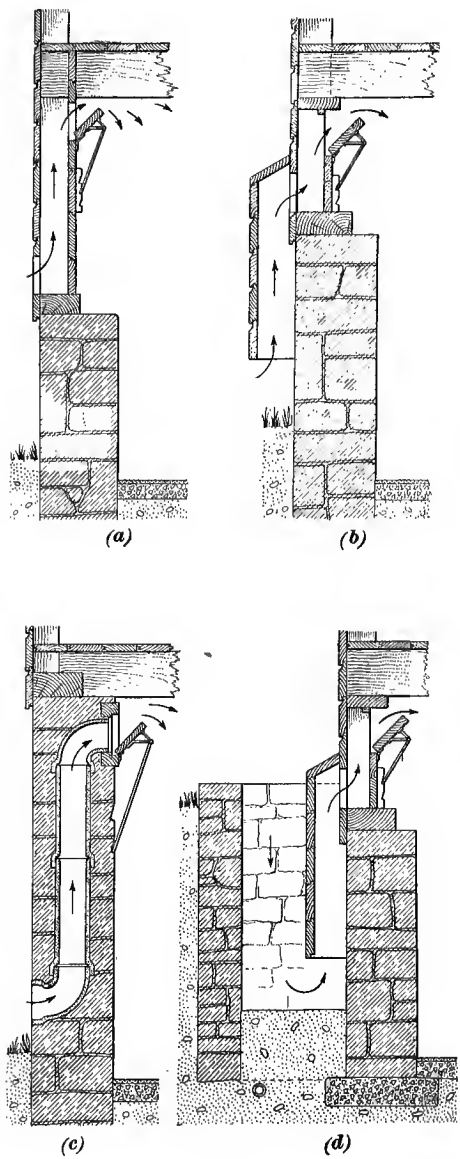


FIG. 12

from the barn. This opening should be provided with a close-fitting door, which is opened only when the temperature of the barn becomes higher than is desired. Various modifications of the plan shown for foul-air flues will, of course, be necessary in different barns. Frequently a single flue is placed in the center of the barn and carried up to a cupola, which serves as an outlet. When a silo is located in the barn, the space between the two walls of the former may be made to serve as a foul-air outlet.

Intakes for fresh air should be placed about 10 feet apart around the outside of the barn. Numerous small intakes are preferable to a few large ones, because the former arrangement facilitates the distribution of fresh air to all parts of the building and is less likely to create

strong drafts. It is essential that the exterior opening of the fresh-air intakes be placed several feet lower than the opening through which the air is discharged into the barn; also, it is important to have the interior openings close to the ceiling. If the interior and exterior openings are at or near the same level, there will be a tendency for the warm air near the ceiling of the barn to flow out through them and thus interfere with the proper working of the ventilating system. The form of intake shown at *b*, Fig. 11, largely overcomes this difficulty, though it is advisable to provide close-fitting doors for either the outside or the inside openings in order that they may be closed when so desired. The fresh-air chutes may be made of lumber or of galvanized iron.

Fig. 12 shows several different forms of inlets applicable to different conditions. For barns having a stone or a brick wall for a part or the whole of the first story, one of the arrangements shown in views (*a*), (*b*), and (*c*) may be used. In view (*d*) is shown a plan for intakes on the bank side of a basement barn. The intakes shown in (*a*), (*b*), and (*d*) are constructed of lumber, and that shown in (*c*) of vitrified sewer pipe.

EQUIPMENT FOR DAIRY BARNS

STANCHIONS AND STALLS

22. Stanchions and **stalls** are devices used to confine cows in their respective places in dairy barns and at the same time allow them the greatest possible freedom to eat, drink, and lie down. There is an almost endless variety of these devices for dairy barns, and while only a few examples of them are illustrated and described here it must not be inferred that they are the only ones that are satisfactory.

A cow stall should be of the simplest possible form. Large, complicated stalls unnecessarily obstruct the floor space, interfere with ventilation, and are difficult to keep clean and sanitary. In order to assist in keeping dairy cows clean, the stalls should be fitted with some device that will cause manure to

be voided into a gutter behind the cows. As a rule, cow stalls are made at least $3\frac{1}{2}$ feet wide, but for extra-large cows they are generally made from 3 to 6 inches wider. The length of a stall depends on whether large, small, or medium-sized cows are to be kept. An average length for a stall is $4\frac{1}{2}$ feet, with a manure gutter from 14 to 18 inches wide and 6 inches deep behind a row of stalls. Stanchions are made of both wood and metal, and as a rule those which are simplest in construction are the most satisfactory.

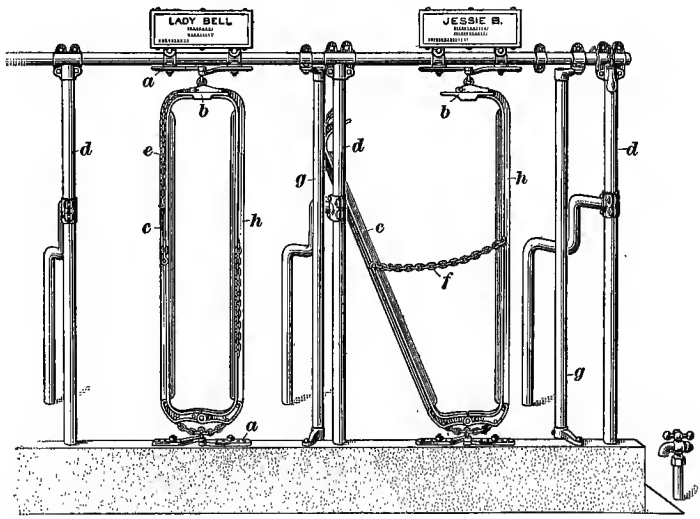


FIG. 13

23. Metal Stanchions.—Properly designed metal stanchions have the advantage of being convenient, practically indestructible, and easily kept clean. In Fig. 13 is shown a front view of two metal stanchions and the frame that supports them. The stanchion at the right is open and the one at the left closed. As shown at *a*, they are secured to the frame by means of adjustable metal pieces that make it possible to set the stanchions forwards in the frame for long cows or backwards for short cows. Each stanchion consists simply of two arms that are suspended by means of a swivel, which arrangement permits a cow to turn her head freely when confined by

the stanchion. These arms are held together by a latch *b*, which, when opened, permits the arm *c*, which is hinged at the bottom, to be pulled out and thus open the stanchion. When the stanchion is open, the hinged arm *c* may be fastened to a rigid stall post *d* by means of a chain *e* attached to this arm, so that a cow when she enters the stall cannot put her head between the hinged arm and the stall post and in this way close the stanchion. Another chain *f* attached to the arm *h* is used to prevent the cow from attempting to pass through the stanchion when it is open, and, if desired, to keep

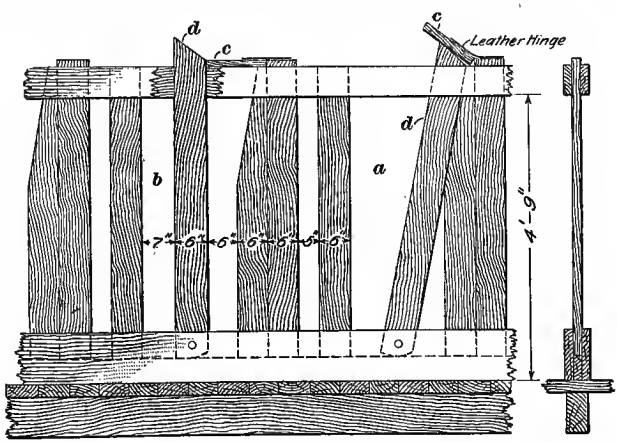


FIG. 14

her from lying down when the stanchion is closed. The cow is prevented from pushing her head through the space between the arm *h* of the stanchion and the rigid stall post by a movable post *g*, which is controlled by a lever located at the end of the row of stanchions and occupies the position shown at the right when the stanchions are open. When cows are in the stalls and secured by closing the stanchions, the swinging posts are thrown into the position shown at the left, where they do not interfere with the free movement of the animals.

24. Wooden Stanchions.—A section of a **wooden stanchion** such as has been extensively used by dairymen for fastening cows in a barn is shown in Fig. 14. Such stanchions

are easily constructed, but they are not looked on with favor by progressive dairymen for the reason that they do not allow the animals to move their heads freely; furthermore, they afford many surfaces and crevices for the collection of dust and dirt. One stanchion is shown open at *a*, and at *b* one is shown closed, a timber having been cut away to show the manner in which the latch *c* holds the movable arm *d* in place when the stanchion is closed.

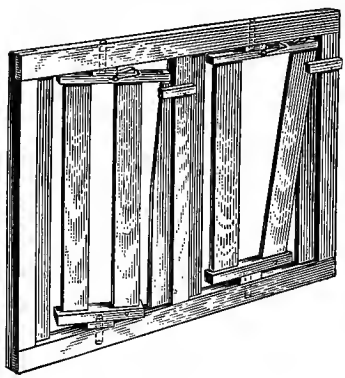


FIG. 15

Wooden stanchions that are pivoted so as to afford greater freedom of movement are shown in Fig. 15. Stanchions of this type are an improvement over those shown in Fig. 10; nevertheless, they are cumbersome and unsanitary.

25. Stanchions of Wood and Metal.—In Fig. 16 is shown a section of stanchions consisting of wood with metal attach-

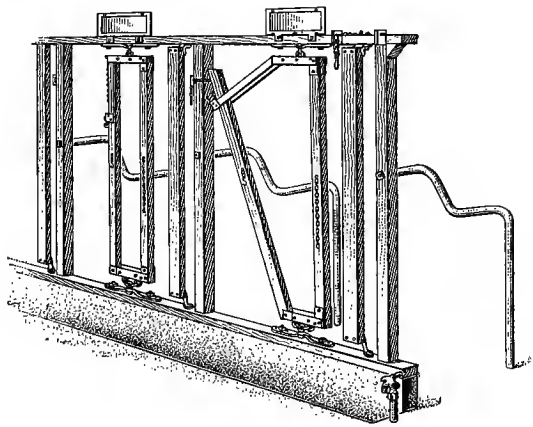


FIG. 16

ments. These stanchions are of a more approved type than either of the wooden stanchions just described. As in the

case of the metal stanchion shown in Fig. 13, this stanchion is equipped with a device by which it may be adjusted to long or short cows. It is also provided with movable posts and chains that prevent the cows from getting their heads in the wrong opening.

26. Van Norman Stall.—Many dairymen regard the **Van Norman stall,** which is illustrated in Fig. 17, as the most satisfactory stall for dairy cows. A 2″×6″ timber *a* separates the stall proper from the manger space in front of it, and as shown at *b*, the stall is provided with a 1″×3″ hardwood bar that is

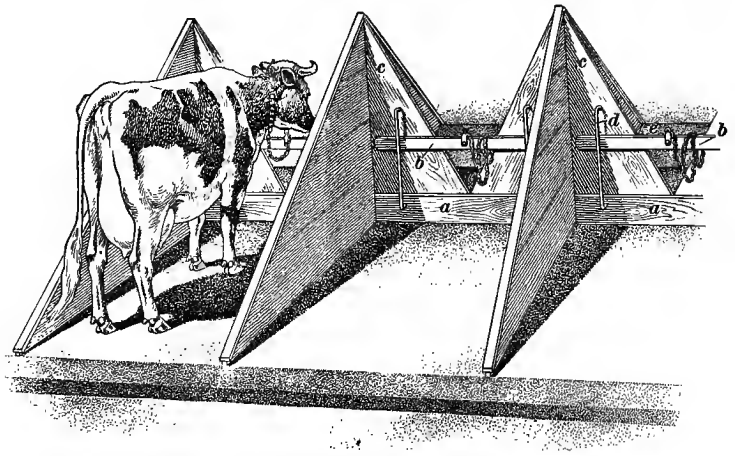


FIG. 17

free to slide up and down between the plank *c* and two metal rods *d*. The purpose of this sliding bar is to give a cow considerable freedom of movement when she is confined to the stall by means of the chain tie attached to this bar. The front wall of this manger, as shown at *e*, is inclined so that the feed placed in it will be kept close to the cow as she eats. The general dimensions of the Van Norman stall are set forth in Fig. 18, which shows a rear elevation, a side elevation, and a section. The details given in these views are sufficient to enable any carpenter to construct such stalls if it is desired to equip a barn with them.

27. Model Stall.—Another type of stall that is extensively used by dairymen for securing cows in a barn is the **Model stall,** one of which is shown in Fig. 19. The Model stall is

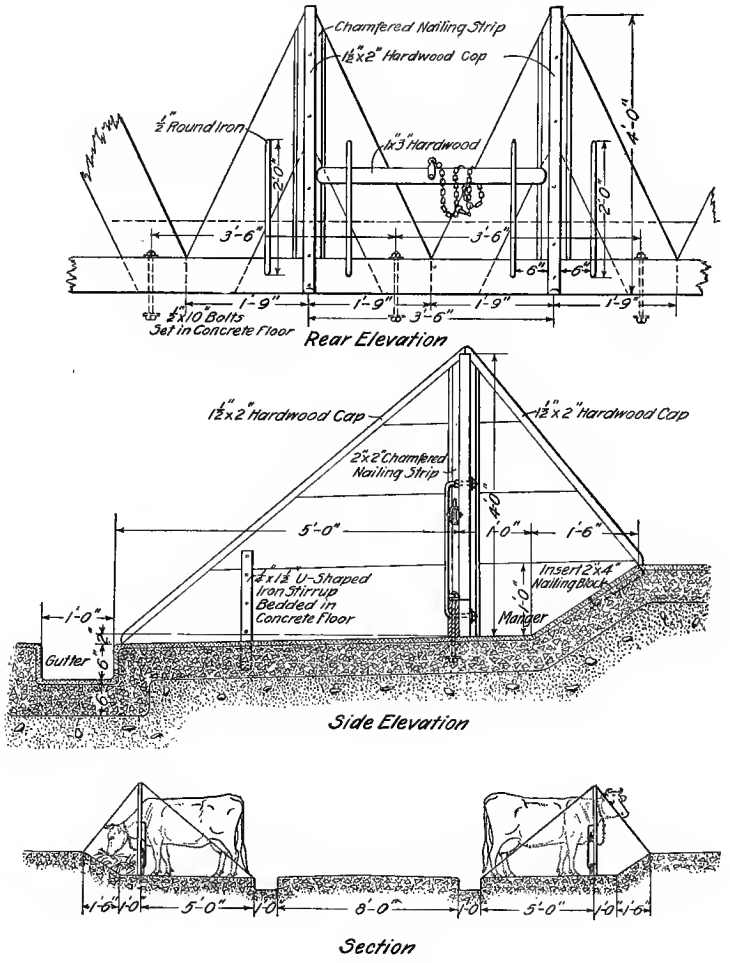


FIG. 18

provided with a chain with which to secure a cow, but its most important feature is the cross-strip shown at *a*. This strip is so placed that a cow while standing in the stall will be inclined

to keep her hind feet back of the strip; hence, any manure dropped by her will fall in or near the gutter *b*. In lying down, however, she will crowd forwards into the stall to avoid the cross-strip and in so doing will avoid any manure that may be on the edge of the gutter. The correct position in which to place the cross-strip in a Model stall will depend, of course, on the size of the cow that is to occupy the stall and is best determined by trial.

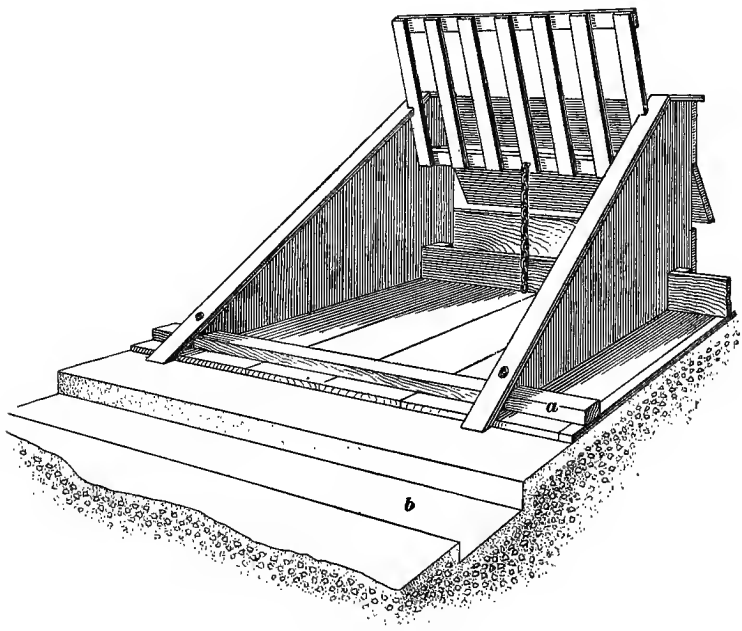


FIG. 19

28. New Ideal Stall.—In Fig. 20 is shown a stall that is somewhat simpler and more sanitary than the one just described and yet accomplishes the same results. It is known as the **New Ideal stall.** A chain tie that slides on gas-pipe arms *a* is employed for fastening the cow. As will be observed, these arms are closer together at the top than at the bottom; thus, when the cow confined in the stall is standing, her hind legs will be near the gutter, but when she lies down the chain on

the rods slides down and draws her toward the front of the stall, away from any manure that may be near the edge of the gutter.

29. Stalls Without Ties or Stanchions.—In Fig. 21 is shown the interior of a modern dairy barn in which use is made of stalls that have neither ties nor stanchions. Each stall is, in fact, a small pen for confining a cow. The stalls consist simply of swinging partitions of iron grating and iron

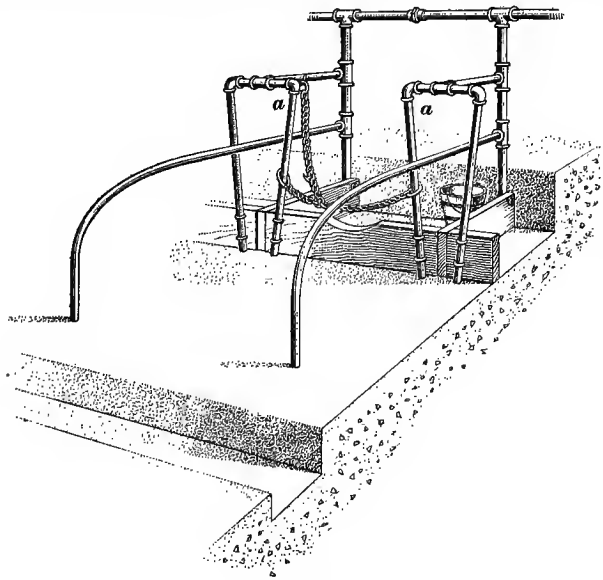


FIG. 20

posts, the bottom ends of which are embedded in the concrete of which the floor and gutter are made. At the top of each post is a groove in which the end of the partition rests when swung down into position, as shown at *a*. These partitions are secured by means of pins, which are so made that chains for preventing the cows from backing out of the stalls can be hooked to them, as shown. In front of the stalls are cement mangers, and on top of these mangers, both in front and at the sides, is an iron grating that prevents the cows from interfering with one another and escaping from the stalls.

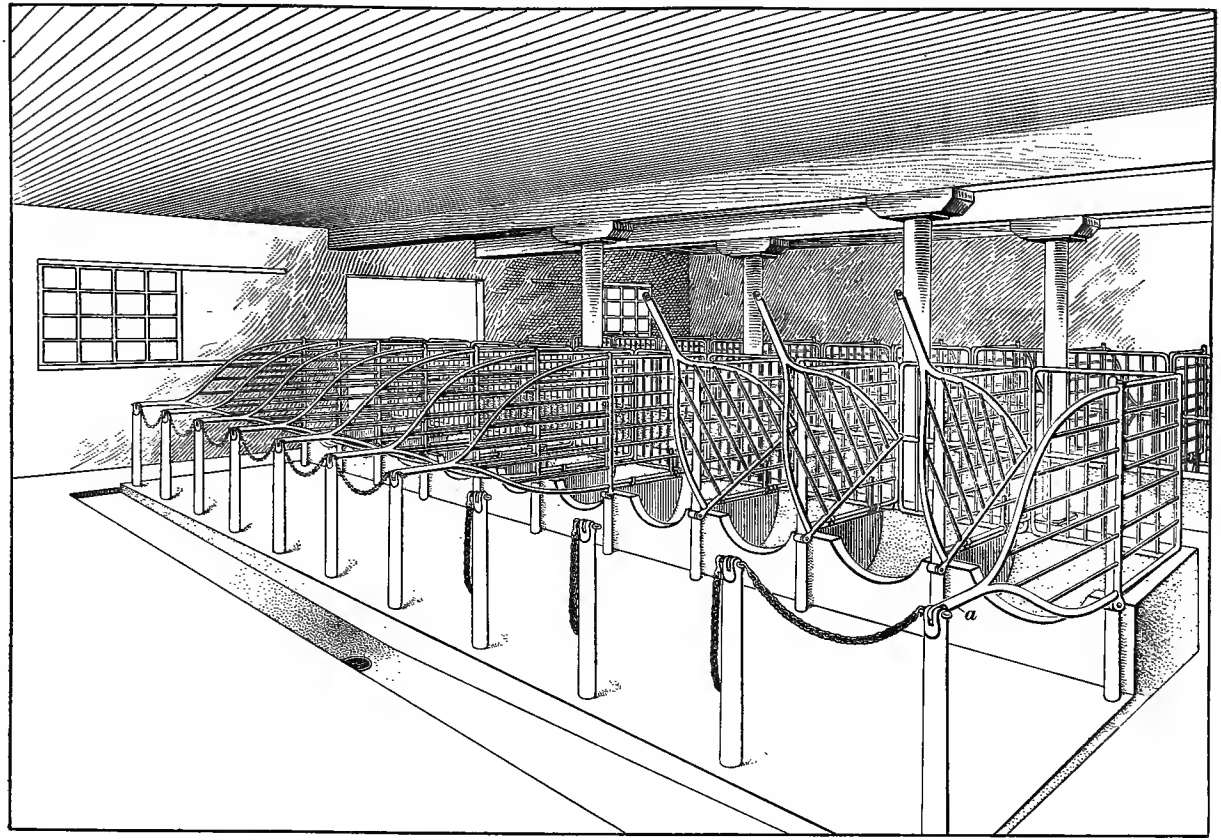


FIG. 21

MANGERS AND WATERING TROUGHS

30. If the floor of a dairy barn is to be of concrete, a concrete manger can be constructed at the time the floor is laid, as has already been explained. Although a manger of this kind possesses many advantages, such as ease in cleaning and convenience in feeding and watering, it is objected to by some dairymen because it does not provide individual compartments for the cows. Under such conditions, it is claimed that

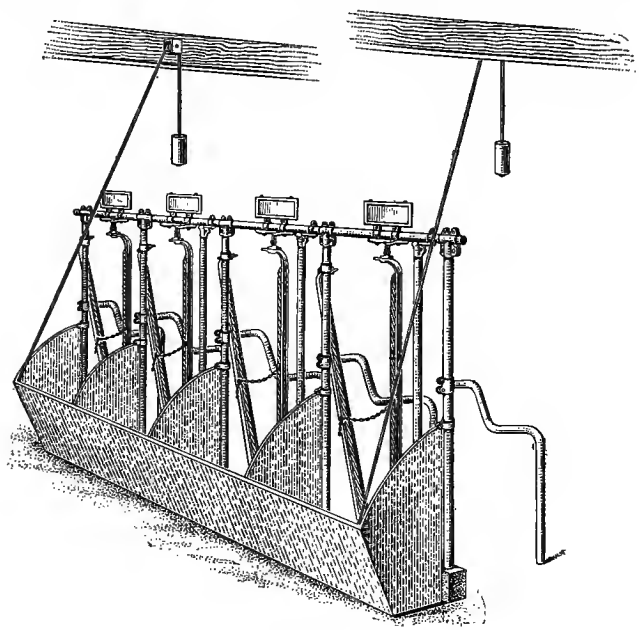


FIG. 22

some cows will get more feed than is allotted to them. To overcome this objection, use is sometimes made of a bottomless manger of galvanized iron like that shown in Fig. 22, although, of course, a similar device made of 1-inch boards will answer the same purpose. This bottomless manger is hinged to the metal posts of the framework that supports the stanchions, and when in position for feeding, as shown in the illustration, it rests on the concrete trough, which forms the bottom of

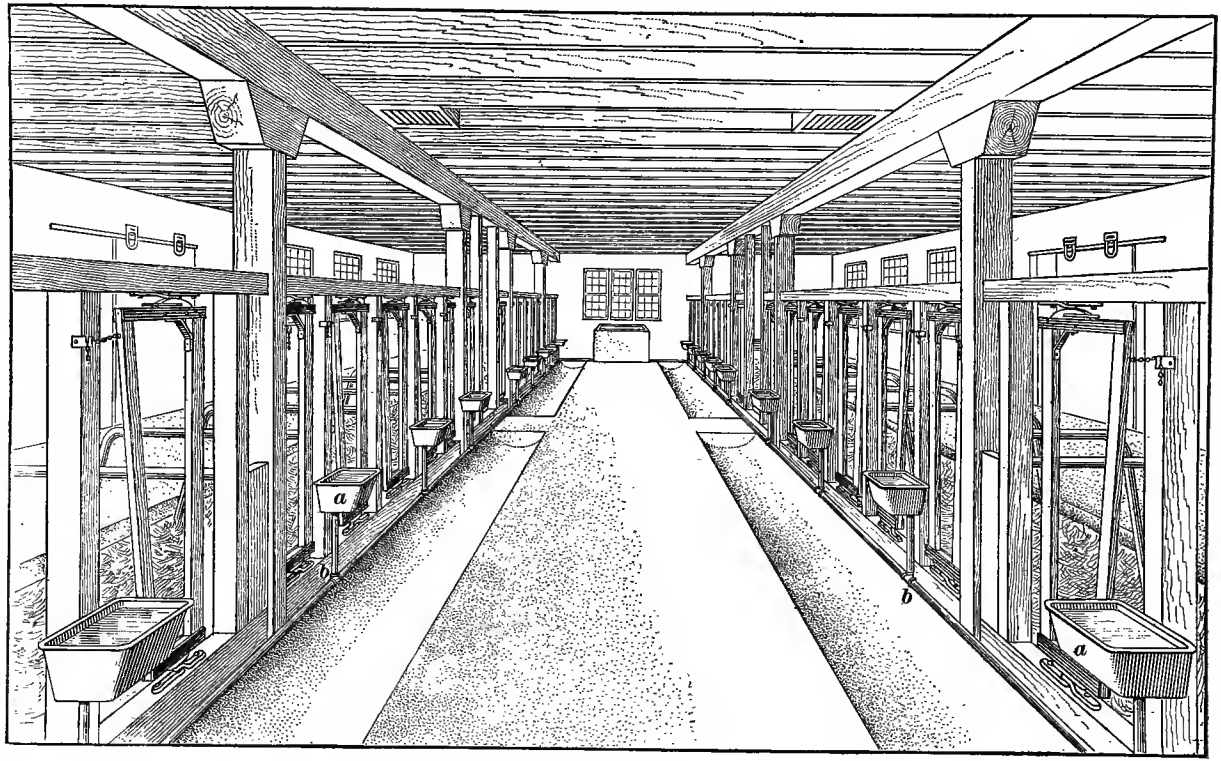


FIG. 23

the manger. Ropes that pass over overhead pulleys and are fitted with counterweights are attached to this bottomless manger, so that it may be raised after the animals have eaten and thus permit the trough to be swept out and filled with water. If it is desired not to use the manger as a watering trough, fixed individual mangers of concrete, lumber, or sheet iron may be installed.

31. In Fig. 23 is shown the interior of a dairy barn fitted with metal watering troughs *a*, each of which will serve two cows. Water is admitted to the troughs through the pipes *b*. By means of a tank and float valve located at one end of the barn, a constant level of water is maintained in these troughs;

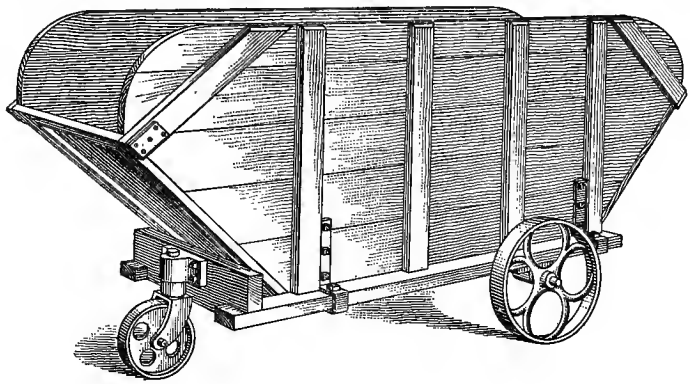


FIG. 24

also, in addition to the tank and float valve, valves for shutting off the water and draining the piping are provided. This method of supplying water to cows in the stalls of a dairy barn is satisfactory, and makes it unnecessary to use the mangers as watering troughs.

CARRYING DEVICES

32. Feed Carriers.—Proper mechanical devices for carrying feed to the cows in a dairy barn are the means of saving considerable time and labor. Many dairymen make use of *feed carts* somewhat similar to the one shown in Fig. 24. Such carts may be purchased from manufacturers of such utensils,

and in most cases they will be found satisfactory for handling silage, grain, etc. Feed carriers consisting of a wooden or a metal box suspended from wheels that run on an overhead track, as shown in Fig. 25, are also used in many dairy barns. The sloping ends of either of these devices make it easy to scoop feed from the box; also, by means of the chain and the worm-gear attachment on the feed carrier, the box can be raised in order to push it along and lowered so that it can be either filled with feed or emptied.

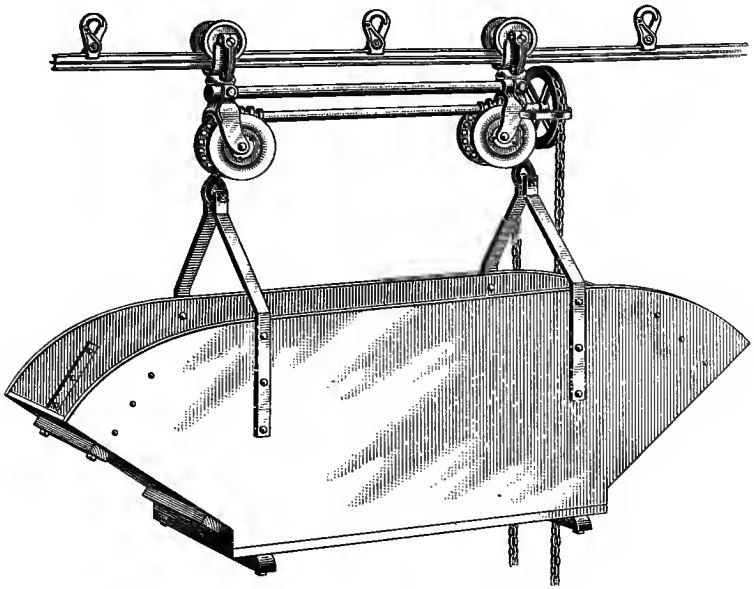


FIG. 25

33. Manure Carriers.—For conveying manure from the gutters of a dairy barn to a manure pit or a manure spreader, carriers similar to that shown in Fig. 25 are extensively used. The overhead track required for such devices is usually extended to the point at which it is desired to discharge the manure, and the carriers are generally so constructed that they can be dumped by means of a trip rope or an automatic trip on the overhead track. In Fig. 26 is shown a dairy barn equipped

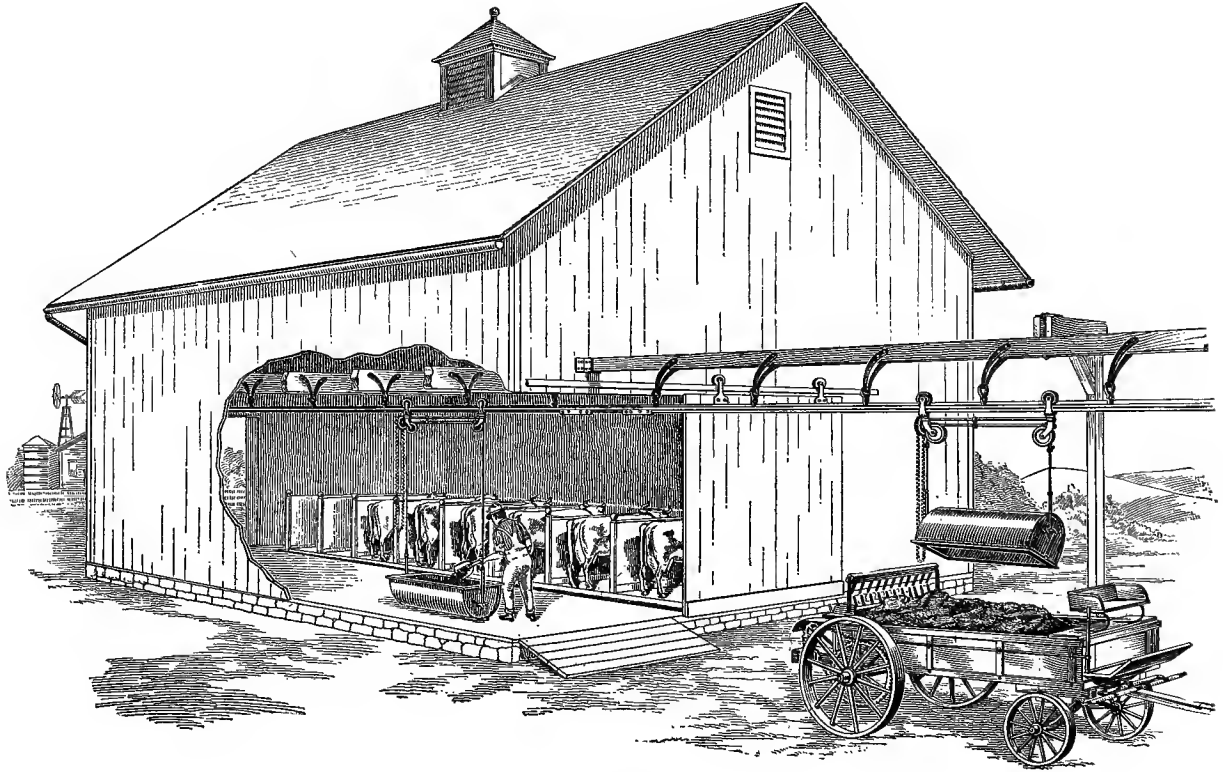


FIG. 26

with a manure-carrying device, as well as a method of extending the track to a manure spreader located outside the barn. A section of the track at the point where it passes through the barn door is made removable so as to permit of closing the sliding door when it is desired to do so. The illustration shows the carrier in two positions—lowered for ease of loading and tripped to discharge its load. In addition to being used as manure carriers, such devices are employed for carrying bedding into the barn and along the rows of stalls.

In some cases, a cable is employed instead of an outside track arrangement. In Fig. 27 is shown a cable arrangement that permits the use of a single carrier along two rows of stalls. When loaded on the cable *a b*, the carrier is pushed around

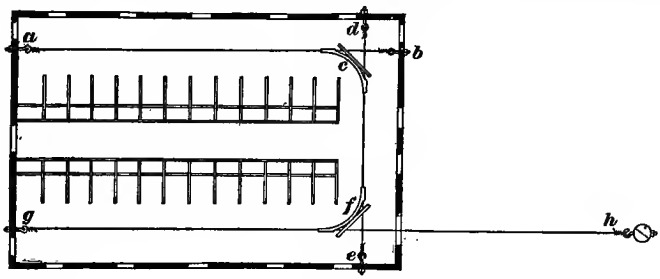


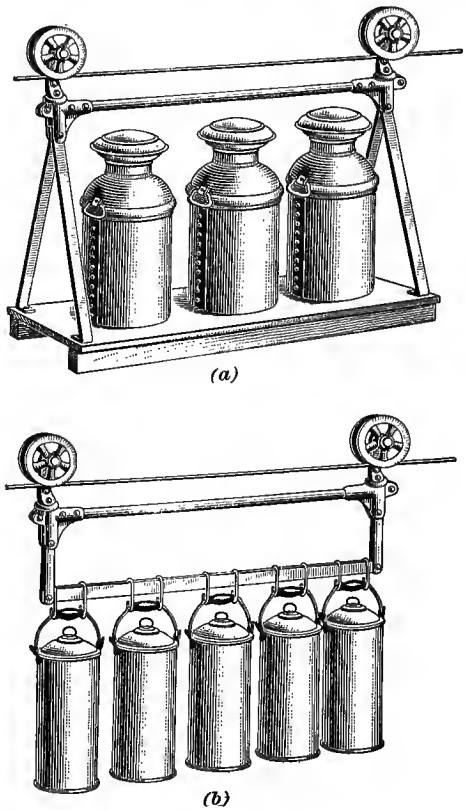
FIG. 27

the curve *c*, along the cable *d e*, and around the curve *f*. A switch near the curve *f* is then opened, and the carrier is pushed along the track *g h* to the dumping point.

34. Milk Carriers.—In order to convey milk from a dairy barn to a milk room or a milk house, particularly, if the latter is located some distance from the barn, use is sometimes made of an ordinary hand truck. A more satisfactory device for this purpose, however, is a carrier that runs on an overhead track similar to that used for manure carriers.

Fig. 28 shows two styles of carriers used for conveying milk from a dairy barn. The one shown in view (*a*) consists of a carriage from which is suspended a platform for receiving milk cans. The carriage runs on an overhead cable or track, which should extend along the alleys behind the cows and to

the milk house. So far as the carriage is concerned, the milk carrier shown in view (*b*) is similar to the one shown in view (*a*). Instead of a platform for the cans, however, this carrier is pro-



(*a*)

(*b*)

FIG. 28

vided with a bar and hooks from which the cans are suspended. In many cases it is possible to operate a milk carrier over part of a manure-carrier track.

EXAMPLES OF DAIRY BARNS

RECTANGULAR BARNS

35. The type of dairy barn most commonly seen is the **rectangular,** or **square-angled, barn.** Barns of this class may be square or oblong, or they may be made up of two or more units combined, the whole forming an L-shaped or a U-shaped structure.

36. Rectangular Barn for Twenty Cows.—A simple form of rectangular barn suitable for housing twenty cows is illus-

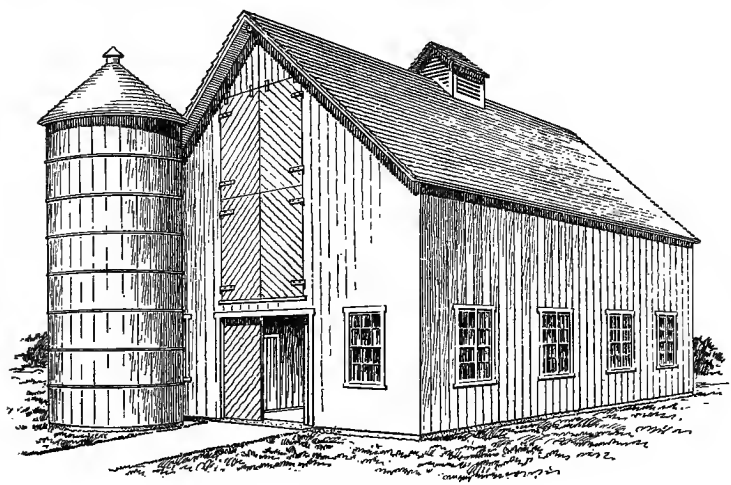


FIG. 29

trated in Figs. 29 and 30. Fig. 29 shows an exterior view of the barn from the silo end, and Fig. 30, a floor plan and side and end elevations. Hay is taken into the barn through the large doors on the second floor, and if a storeroom for feed is provided on this floor, bags of feed may also be hoisted and swung into the barn at this point. For convenience in getting

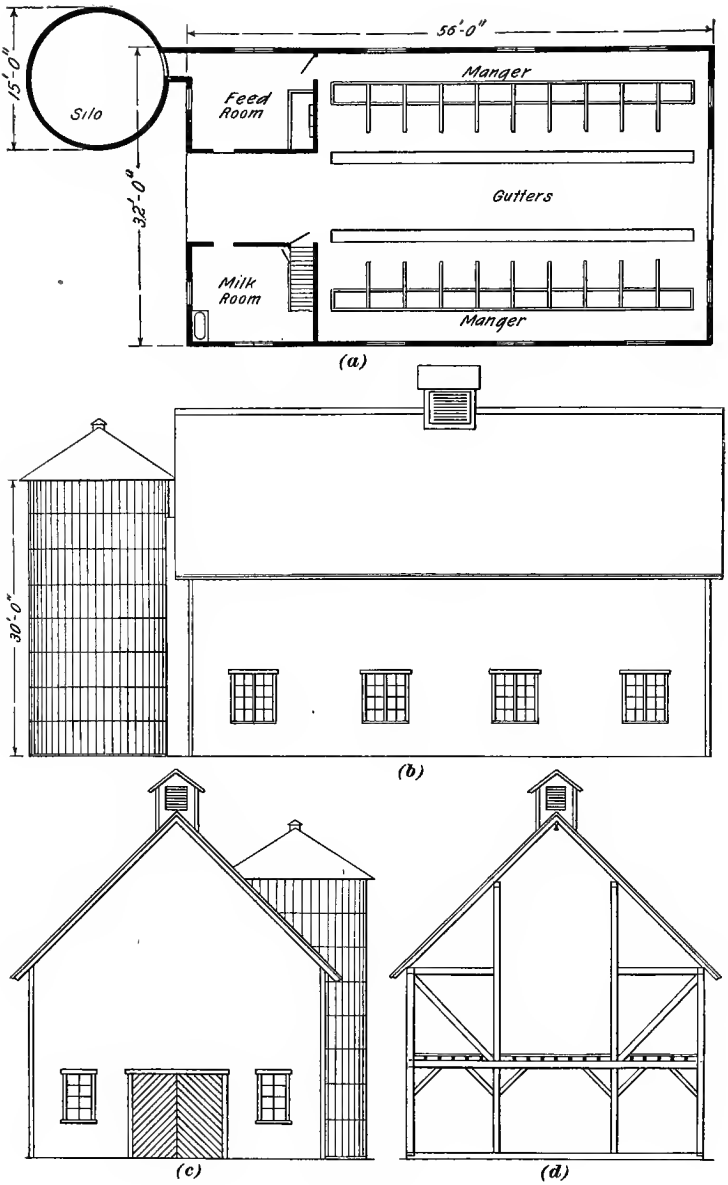

56'-0"
15'-0"
Silo
Feed Room
Manger
32'-0"
Gutters
Milk Room
Manger
(a)
30'-0"
(b)
(c)
(d)

FIG. 30

loads of hay and grain directly under these doors, it would, perhaps be better to place the silo at the side of the barn rather than at the end.

On referring to the floor plan shown in Fig. 30 (*a*), it will be seen that the barn contains a double row of ten stalls so arranged that the cows will face away from each other. Between the gutters behind these stalls, that is, through the center of the barn, is a driveway, which makes it possible to drive a wagon or a manure spreader in behind the cows and load the manure directly from the gutters. The interior arrangement is also satisfactory for the installation of a manure carrier such as has been described. The dimensions of this barn are as follows: Length, 56 feet; width, 32 feet; height at eaves, 18 feet, of which 10 feet of space is given over to the first floor. The feed room and the milk room, which are located in the front part of the barn, are each 11 feet wide and 14 feet long, but they may, if desired, be reduced sufficiently to make room for two or more additional stalls. This barn makes no provision for the stabling of calves nor for a box stall for a bull, but a builder can easily provide for these by adding a shed or increasing the length of the structure. The side and end elevations of this barn are shown in views (*b*) and (*c*). Bins for the storage of feed may be constructed on the second, or mow, floor directly over the feed room on the first floor and connected with the latter with chutes.

In (*d*) is shown the arrangement of timbers for one bent of the barn. This construction affords an unobstructed space from floor to roof in the center of the mow, thus facilitating the handling of hay. The framework of the barn may be entirely of 2-inch stuff, which material is inexpensive and easily handled.

37. One-Story Barn for Twenty Cows.—Another plan for a barn suitable for housing twenty cows is illustrated in Fig. 31, in which (*a*) shows the floor plan and (*b*) an end elevation. In this barn, as will be observed, the stalls are arranged so that the cows will face one another, thus bringing the mangers adjacent to the central driveway. As pointed out elsewhere, such

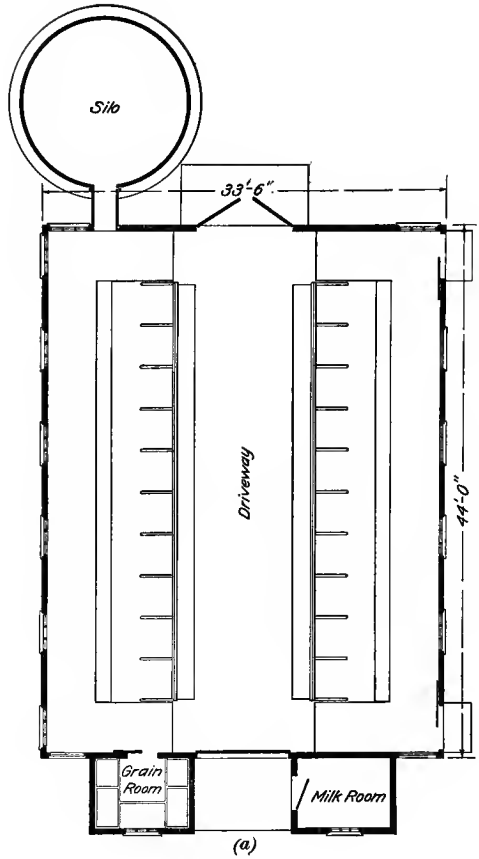
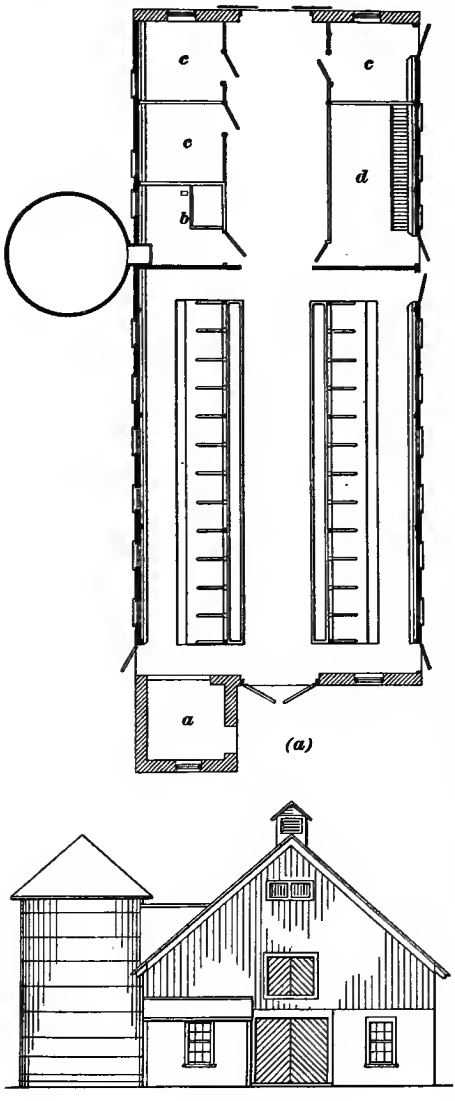


FIG. 31

an arrangement is somewhat objectionable, but some dairymen seem to prefer it. A feed room and a milk room are arranged in a lean-to shed, as shown. The plan for the structure, however, makes no provision for the storage of hay; nevertheless, a mow could be arranged for by increasing the height of the building. The length of the barn is 44 feet and its width is 36½ feet. A box stall for a bull and a calf pen or a double row of calf stanchions could be added by increasing the length about 10 feet. The feed room communicates directly with the interior of the barn, but the milk room is separated from it by a solid wall, which should exclude barn odors to a large extent. The entrance to the milk room is from the passageway between it and the feed room.



(a)

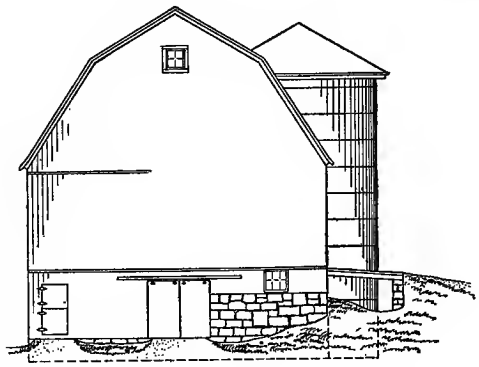
(b)

FIG. 32

38. Barn for Twenty-Four Cows.—In Fig. 32 is shown the floor plan and an end elevation of a dairy barn arranged to accommodate twenty-four cows. This barn

also contains a few features not heretofore shown. According to the floor plan (*a*), provision is made for twenty-four stalls which are arranged so that the cows will face one another, a milk room *a*, a feed room *b*, three box stalls *c*, and a calf pen *d*. If it is desired to stable more than twenty-four cows, the calf pen and the box stall adjoining could be omitted and the space thus gained used to stable about eight more cows, thus increasing the capacity of the barn to thirty-two cows. The feed room *b* communicates with the silo, and hay is dropped into this room from the mow floor through a chute.

The end elevation referred to is shown in (*b*). The height of the structure is sufficient to provide for a haymow, and, if



END ELEVATION

FIG. 33

desired, a room for storing feed could be placed directly over the feed room of the first floor. Hay can be taken into the mow either through the doors shown in the end elevation or through an opening in the mow floor in the center of the barn, directly over the driveway. An opening of this kind, however, is somewhat objectionable on account of the dust and litter that is usually scattered in the barn while hoisting hay, and also on account of the difficulty of making the overhead opening into the mow dust-tight. Tight-fitting trap doors are sometimes placed in such openings, but if they are not provided, more or less dust from the mow will continually sift down into the part of the barn occupied by the cows.

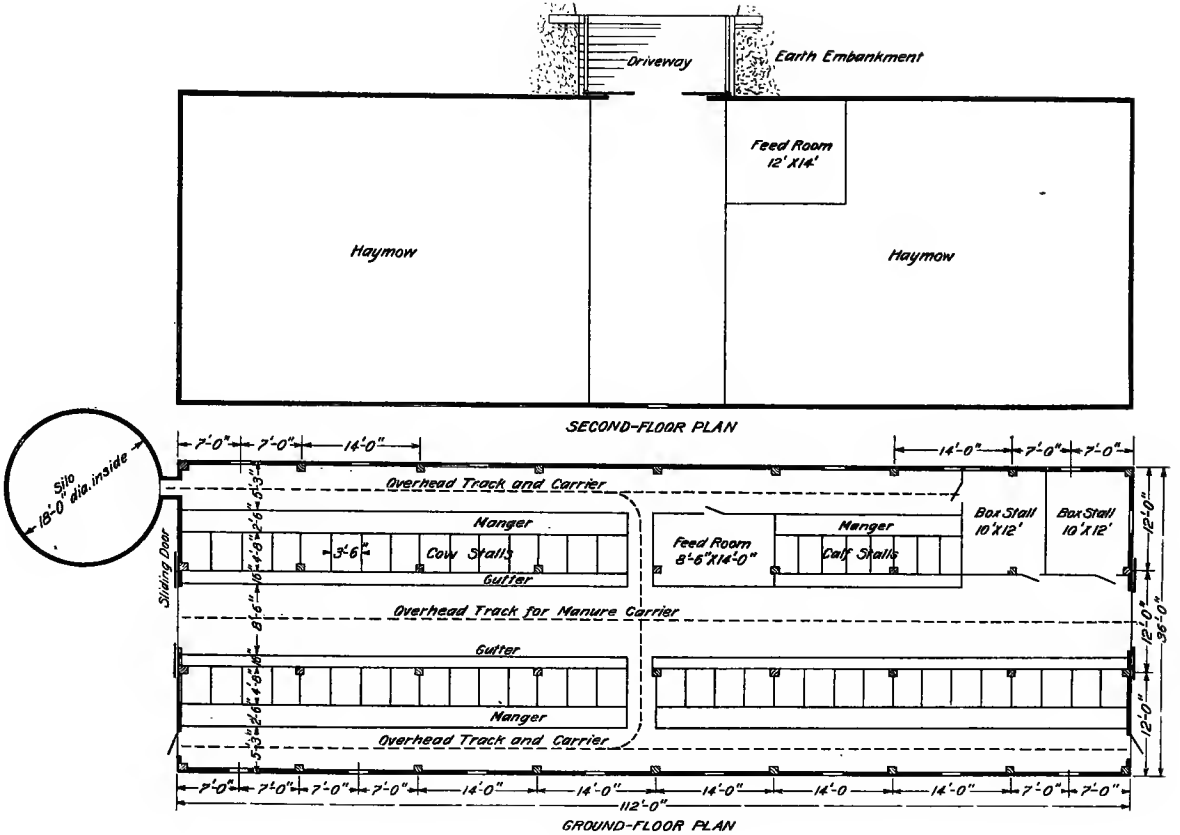

Driveway
Earth Embankment
Feed Room
12' X14'
Haymow
Haymow
SECOND-FLOOR PLAN
Silo
18'-0" dia. inside
Sliding Door
Overhead Track and Carrier
Manger
Cow Stalls
Gutter
Feed Room
8'-6" X14'-0"
Manger
Calf Stalls
Box Stall
10'X12'
Box Stall
10'X12'
Overhead Track for Manure Carrier
Gutter
Manger
Overhead Track and Carrier
112'-0"
GROUND-FLOOR PLAN

FIG. 34

39. Barn for Forty-Six Cows.—In Fig. 33 is shown the end elevation of a dairy barn containing sufficient stalls to accommodate forty-six cows. These stalls are arranged as shown in the ground-floor plan, Fig. 34; that is, so that the cows face away from one another. In addition to the cow stalls, there are two box stalls, eight calf stalls, and a feed room on the ground floor. If desired, a milk room could be substituted for one of the box stalls. As will be seen, an overhead track for a manure carrier is placed between the rows of stalls, and overhead tracks for a feed carrier run along each feed alley in front of the mangers. These tracks cross the manure-carrier track in the center of the barn, a section of the latter track being removable to permit the passage of the feed carrier. Hay is delivered into this barn by driving the hay wagon directly into the mow over a bridge shown in the second-floor plan and in the end elevation, Fig. 33. Feed also may be taken into the mow in the same manner and stored in the second-floor feed room, which is connected with the feed room on the first floor by chutes.

40. Model Barn for Eighteen Cows.—Two views of the exterior of a model dairy barn located in Northeastern Pennsylvania and owned by T. J. Foster are shown in Figs. 35 and 36. Connected to the barn, as shown in the side elevation, Fig. 35, is a feed room with a silo partly enclosed in it, and alongside of the feed room, extending to a manure shed, is an overhead track for a manure carrier. On the opposite side of the barn, as shown in Fig. 36, is a combination ice house and milk house.

The interior arrangement of this barn, feed room, and silo, as well as their dimensions, is shown in Fig. 37. As will be seen in the ground-floor plan, two rows of stalls sufficient in number to accommodate eighteen cows face a central feedway, and in one corner is a box stall for a bull. This floor plan also shows the arrangement of the overhead tracks for the manure carrier and the feed chutes leading from the feed bins on the second floor. Hay is stored on the second floor of the main part of the barn, and, as shown in the second-floor

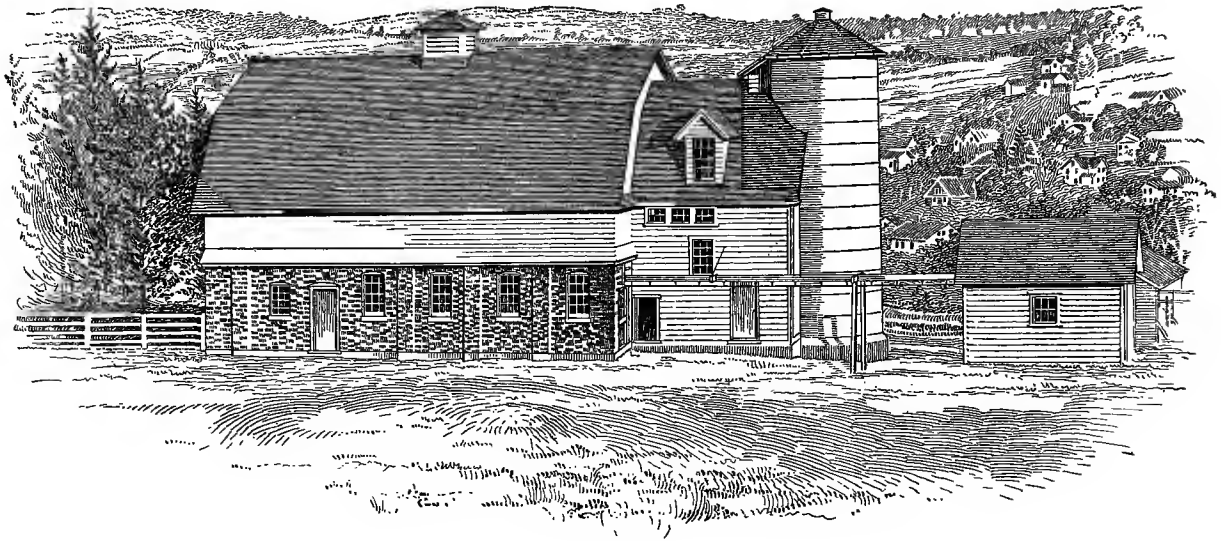


FIG. 35

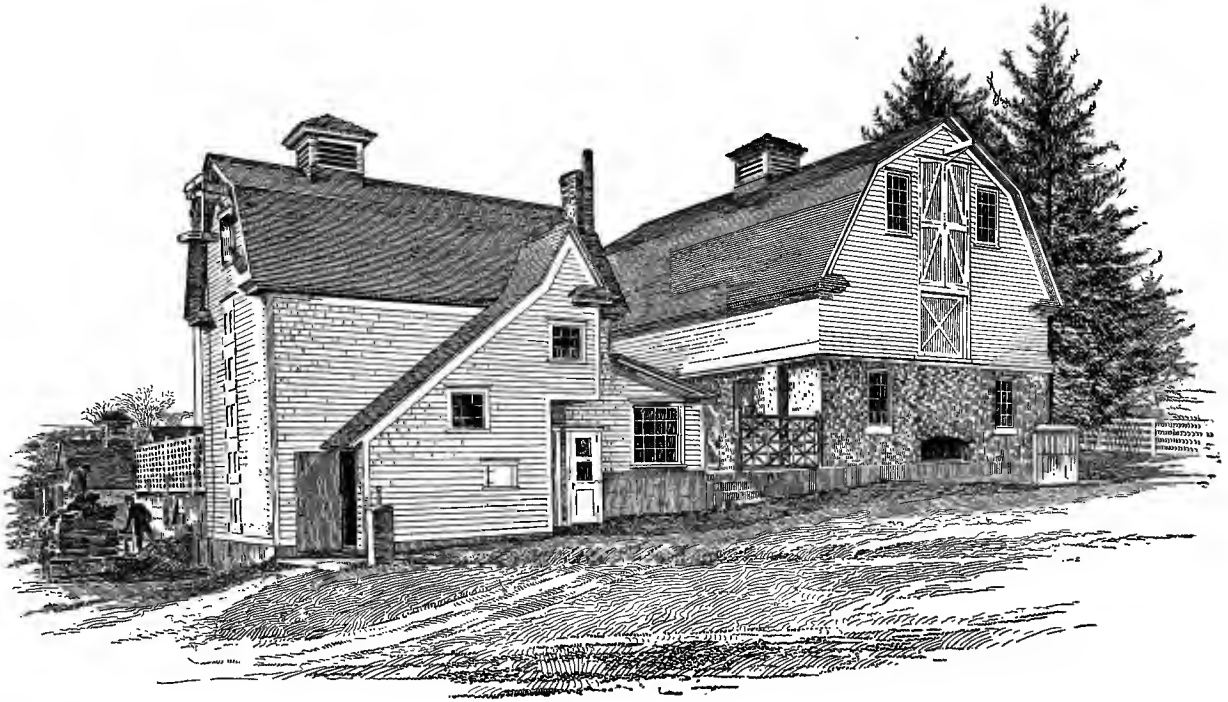


FIG. 36

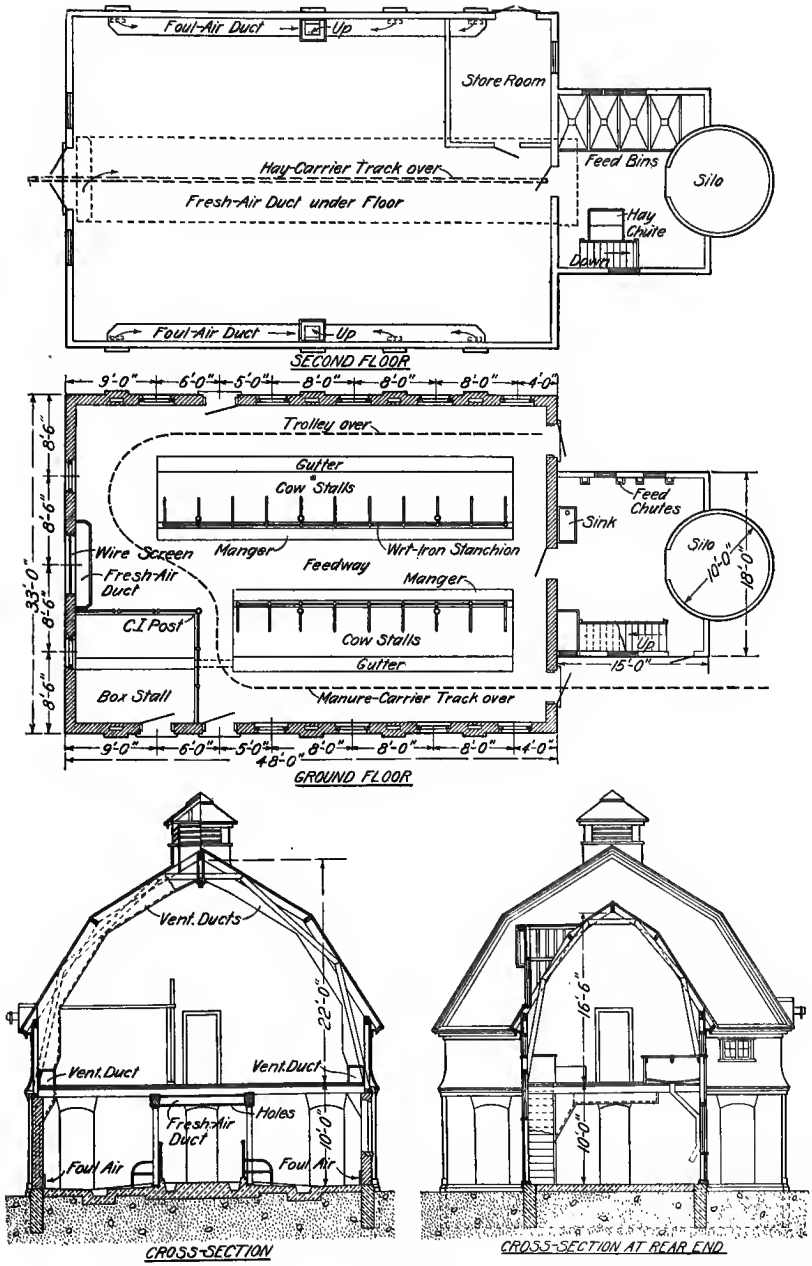

Foul-Air Duct
Up
Store Room
Hay-Carrier Track over
Fresh-Air Duct under Floor
Feed Bins
Silo
Hay Chute
Down
Foul-Air Duct
Up
SECOND FLOOR
9'-0"
6'-0"
5'-0"
8'-0"
8'-0"
8'-0"
4'-0"
Trolley over
Gutter
Cow Stalls
Feed Chutes
Sink
Silo
10'-0"
18'-0"
Wire Screen
Manger
Wrt-Iron Stanchion
Feedway
Manger
Fresh-Air Duct
C.I Post
Cow Stalls
Gutter
Up
15'-0"
Box Stall
Manure-Carrier Track over
33'-0"
8'-6"
8'-6"
8'-6"
8'-6"
48'-0"
GROUND FLOOR
Vent. Ducts
22'-0"
Vent. Duct
Vent. Duct
Holes
Fresh-Air Duct
10'-0"
Foul Air
Foul Air
CROSS-SECTION
16'-6"
10'-0"
CROSS-SECTION AT REAR END

FIG. 37

plan, provision is made for a hay-carrier track. This plan shows also a store room and a hay chute, through which hay is delivered to the first floor of the feed room.

This dairy barn is equipped with a ventilation system that is a modification of the King system already described. The arrangement of the ventilator ducts is clearly shown in the cross-sectional views, Fig. 37. Only one fresh-air inlet is provided. It is located near the ground level, directly below the hay doors, as shown in Fig. 36. Fresh air admitted through this opening, which is fitted with a screen, passes up to the ceiling of the first floor inside the barn through the air duct shown in the ground-floor plan and the left-hand cross-sectional view. This duct extends under the floor of the second story of the barn, as shown by the dotted lines in the second-floor plan, and a series of 1-inch auger holes in the lower surface of this duct permit fresh air to enter the barn without creating any objectionable drafts.

In Fig. 38 is shown a view of part of the interior of this dairy barn. This illustration shows the type of stalls and stanchions used, as well as a section of the overhead track for the manure carrier.

41. A Wisconsin Dairy Barn.—In Fig. 39 is shown in side elevation a Wisconsin dairy barn erected with the idea of providing ideal sanitary conditions for the production of certified milk. As shown in the floor plans, Fig. 40, the barn is built with its largest dimension extending east and west. However, the owner of the barn advises that if he were to build another such barn he would place the axis in a north-and-south direction if possible. A system of removing manure from the gutters by means of a shovel or a scraper device has been added since the barn was completed. The gutters have been extended to the exterior of the barn, ending at an excavated driveway, as shown at the right in Fig. 39, in which a manure spreader is placed. The removal of the manure from the gutters behind the cows is accomplished by drawing a scraper along each gutter and out through an opening in the end of the barn to the manure spreader. The scraper is drawn

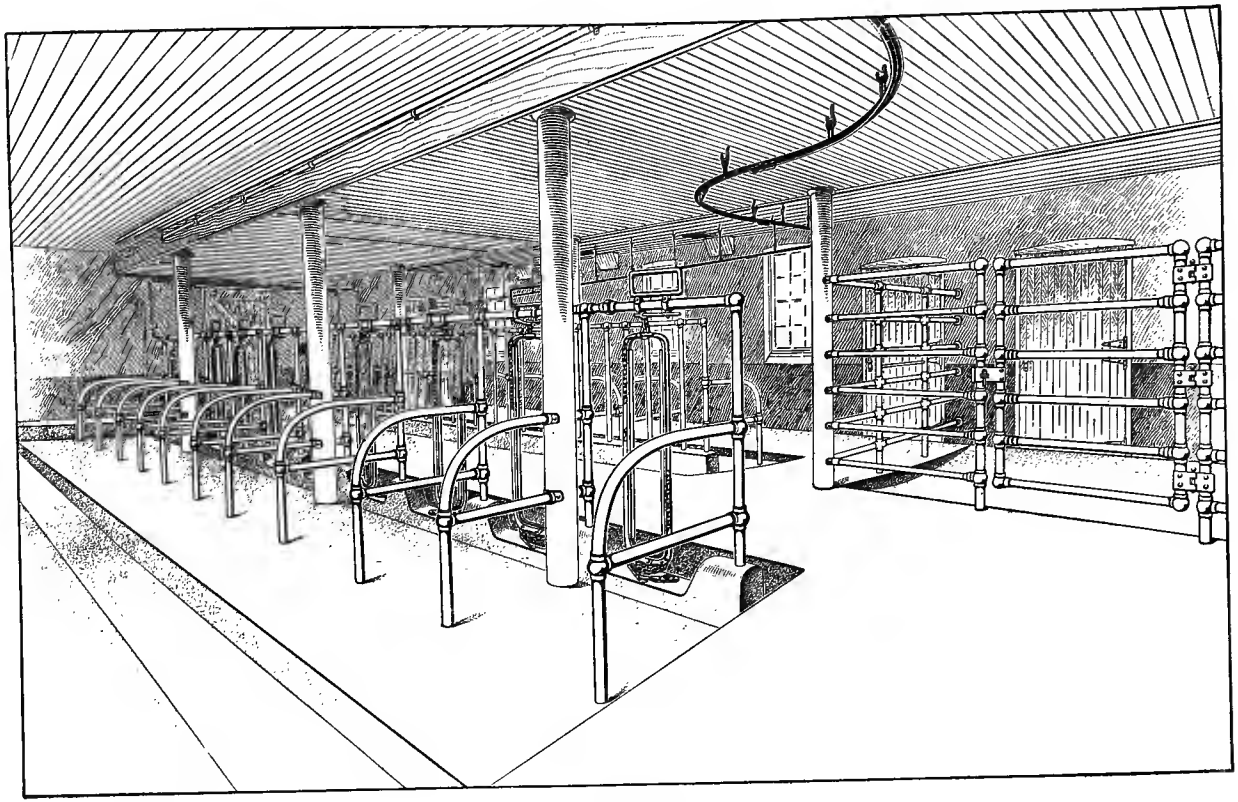


FIG. 38

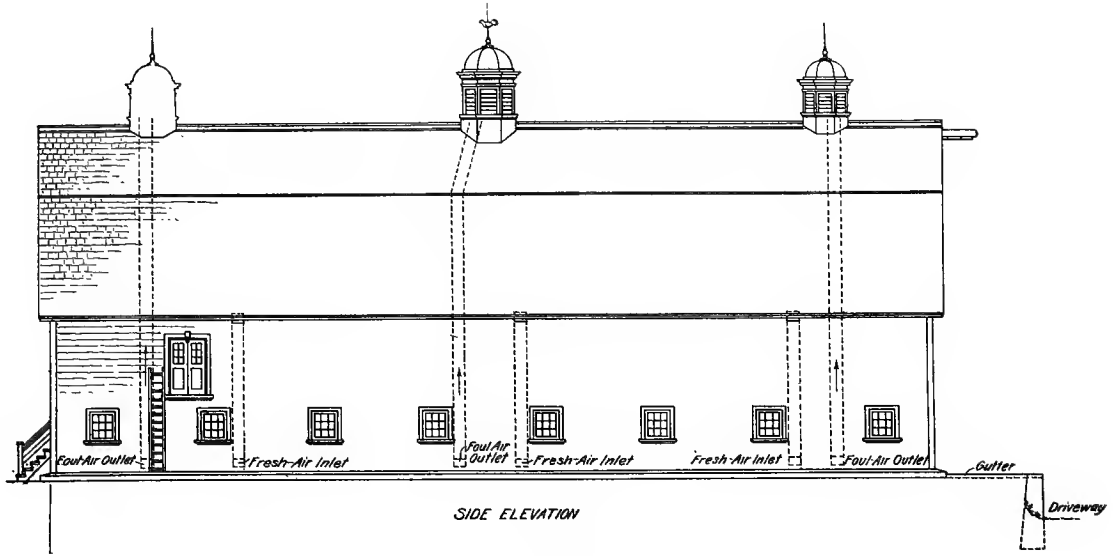

Foul-Air Outlet
Fresh-Air Inlet
Foul Air Outlet
Fresh-Air Inlet
Fresh-Air Inlet
Foul-Air Outlet
Gutter
Driveway
SIDE ELEVATION

FIG. 39

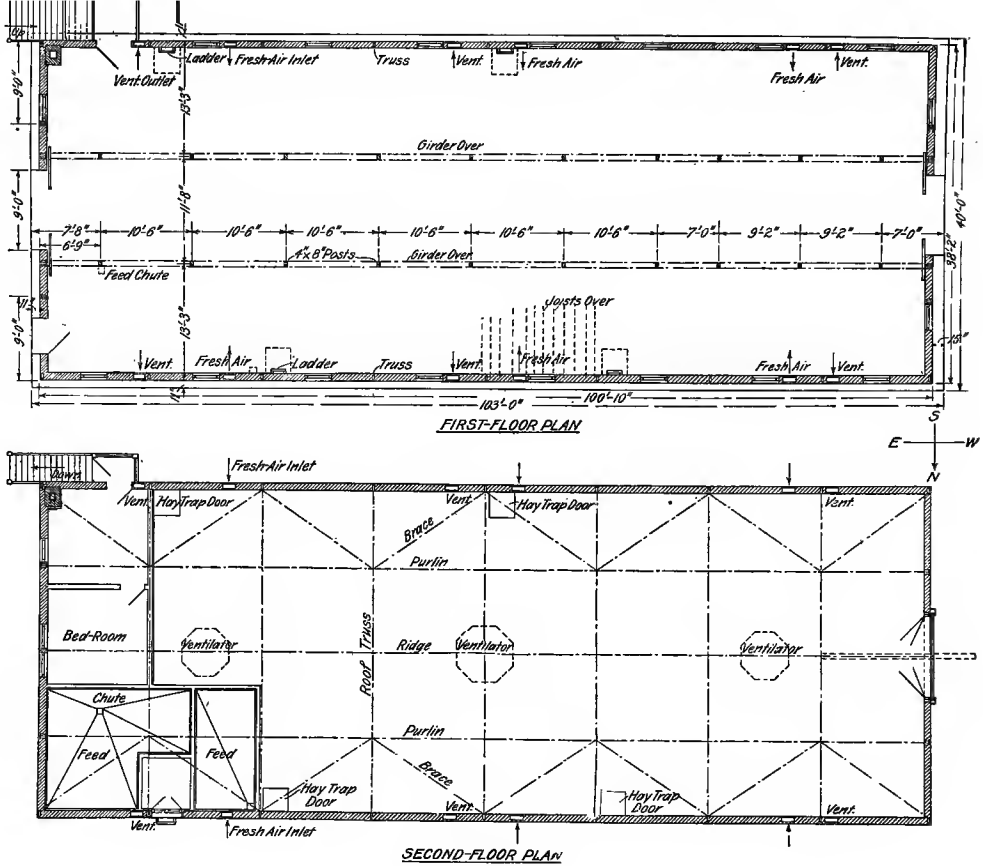

Vent. Outlet
Ladder
Fresh Air Inlet
Truss
Vent.
Fresh Air
Fresh Air
Vent.
Girder Over
7'-8"
10'-6"
10'-6"
10'-6"
10'-6"
10'-6"
7'-0"
9'-2"
9'-2"
7'-0"
6'-9"
4"x8" Posts
Girder Over
Feed Chute
Joists Over
Vent.
Fresh Air
Ladder
Truss
Vent.
Fresh Air
Fresh Air
Vent.
103'-0"
100'-10"
FIRST-FLOOR PLAN
S
E
W
N
Stairs
Fresh Air Inlet
Vent.
Hay Trap Door
Hay Trap Door
Vent.
Vent.
Brace
Purlin
Bed-Room
Ventilator
Truss
Ridge
Ventilator
Ventilator
Roof
Chute
Feed
Feed
Purlin
Brace
Hay Trap Door
Vent.
Hay Trap Door
Vent.
Vent.
Fresh Air Inlet
SECOND-FLOOR PLAN

FIG. 40

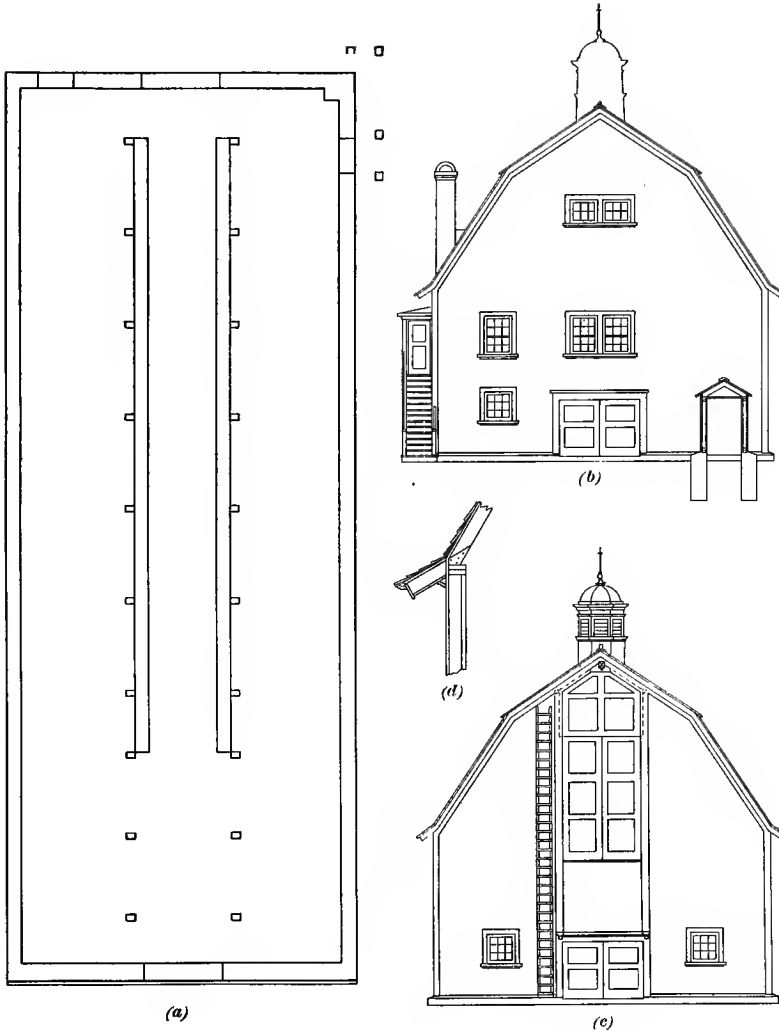


FIG. 41

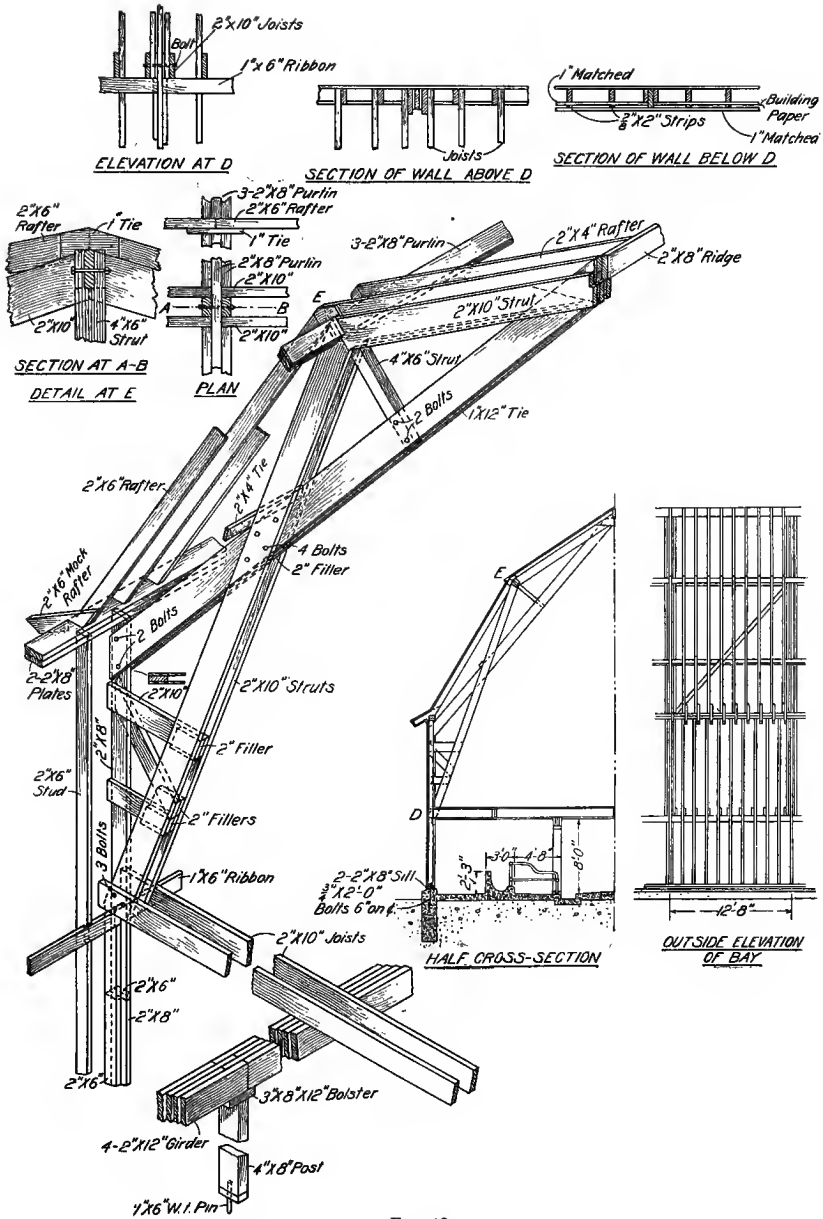

2"x10" Joists
Bolt
1"x6" Ribbon
ELEVATION AT D
Joists
SECTION OF WALL ABOVE D
1" Matched
Building Paper
8" x2" Strips
1" Matched
SECTION OF WALL BELOW D
2"X6" Rafter
1" Tie
2"X10"
4"X6" Strut
SECTION AT A-B
DETAIL AT E
3-2"X8" Purlin
2"X6" Rafter
1" Tie
2"X8" Purlin
2"X10"
2"X10"
PLAN
3-2"X8" Purlin
2"X4" Rafter
2"X8" Ridge
2"X10" Strut
4"X6" Strut
2 Bolts
1"X12" Tie
2"X6" Rafter
2"X4" Tie
4 Bolts
2" Filler
2"X6" Mach Rafter
2 Bolts
2-2"X8" Plates
2"X10"
2"X10" Struts
2"X8"
2" Filler
2"X6" Stud
2" Fillers
3 Bolts
1"X6" Ribbon
2"X10" Joists
2"X6"
2"X8"
2"X6"
3"X8"X12" Bolster
4-2"X12" Girder
4"X8" Post
1"X6" W.I. Pin
E
D
2-2"X8" Sill
12"X12"-0" Bolts 6' on ℄
3'-0"
4'-8"
8'-0"
HALF CROSS-SECTION
12'-8"
OUTSIDE ELEVATION OF BAY

FIG. 42

by a horse hitched to a rope that is attached to the scraper and extends out through the opening for the extension of the gutter in the end of the barn.

The arrangement of ventilation flues and inlets for this barn is shown by dotted lines in Fig. 39. By referring to the first-floor plan, Fig. 40, the flues and inlets will be seen in cross-section, the former being marked *vent* and the latter marked *fresh air*.

Two rooms for a herdsman are provided on the second floor of this barn, on which floor are also located two bins for storage of feed. Feed to be stored in these bins is hoisted to the level of this floor and taken in through double doors, shown in the side elevation, Fig. 39, that open into a small enclosure near the feed bins. Hay is taken into the mow through hay doors shown at the west end of the second-floor plan, Fig. 40.

In Fig. 41 (*a*) is shown the foundation plan of this dairy barn. The foundation wall extends around the entire structure, and through the center is a double row of cement supports. Cement gutters extend about three-fourths of the way through the barn, and at the upper right-hand corner are located cement footings for the support of the outside stairway of the barn. In view (*b*) of this illustration is shown an east-end elevation, and in view (*c*), a west-end elevation. View (*d*) shows a detail of the construction at the eaves. Additional details pertaining to the construction of this dairy barn are illustrated in Fig. 42. However, a full discussion of the numerous details shown here is scarcely required for the present purpose. They should be self-explanatory to any builder, and in case it is desired to construct a barn on this plan they should be placed in the hands of the builder for his guidance. Aside from this use they have no important bearing on the general subject of dairy barns.

42. Barn of the South Dakota Agricultural College.—The dairy barn erected at the South Dakota Agricultural College is of interest, inasmuch as it is a model structure of its kind. It includes some features that would not be required in an ordinary dairy barn, but these could easily be omitted or altered,

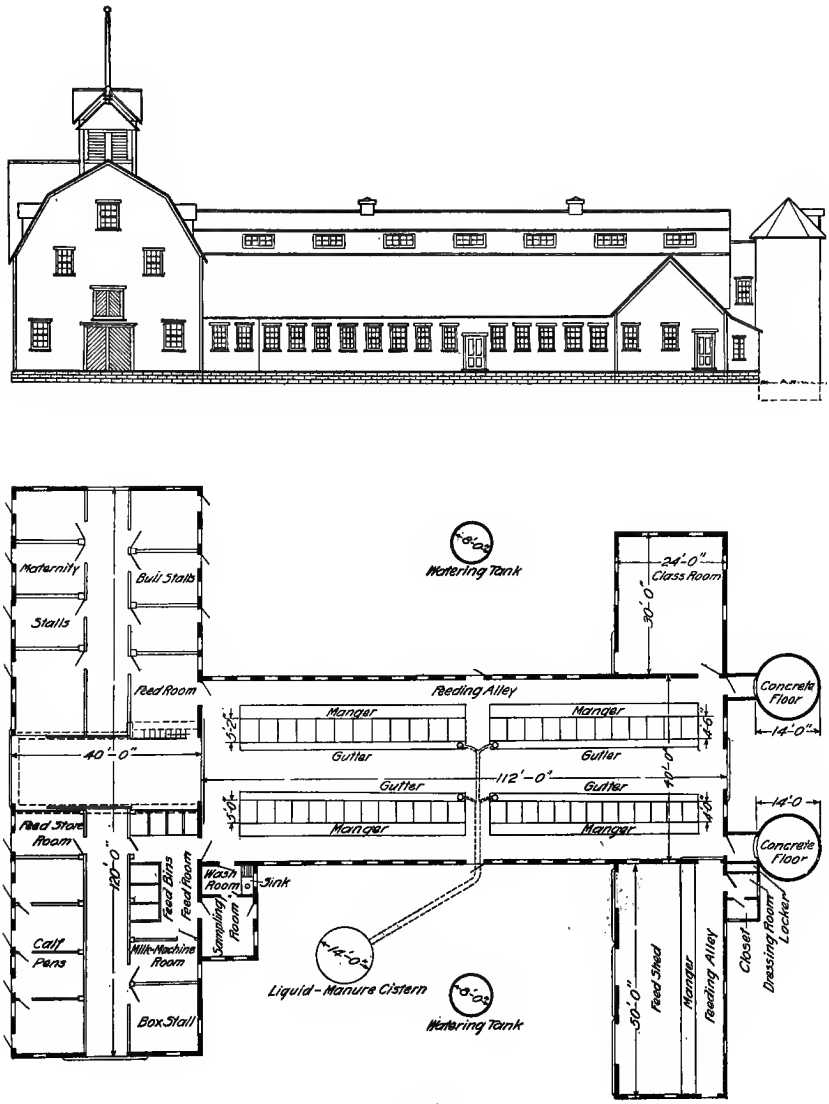

Maternity
Stalls
Bull Stalls
Feed Room
40'-0"
Feed Store Room
120'-0"
Calf Pens
Feed Bins
Feed Room
Wash Room
Sink
Sampling Room
Milk-Machine Room
Box Stall
Watering Tank
Feeding Alley
Manger
Gutter
5'-2"
4'-6"
112'-0"
40'-0"
24'-0"
Class Room
30'-0"
Concrete Floor
14'-0"
Liquid-Manure Cistern
14'-0"
50'-0"
Feed Shed
Manger
Feeding Alley
Closet
Dressing Room
Locker

FIG. 43

if desired. A side elevation and a ground plan of this building are shown in Fig. 43. As will be seen, the ground floor of part of the barn is utilized for maternity, or calving, stalls, bull stalls, feed rooms, calf pens, a milk-machine room, and a box stall. The loft above these rooms and stalls is used for the storage of hay and feed. As shown, there are stalls for fifty cows in an adjoining part of the barn, and on the floor above these stalls there is additional mow room. Particular attention is directed to the manner in which stalls of different length are secured. In one row, the first stall is 5 feet 2 inches long and the last stall is 4½ feet long, with a gradual taper between the two extremes. The other row of stalls tapers from 5 feet at one end to 4 feet at the other end. It is thus possible to stable a cow in a stall of suitable length. Two wings at the end of the part of the barn containing the cow stalls provide for a class room on one side and a feed shed on the other. A dressing room, a closet, and a locker are also located near one of these wings. Besides the features mentioned, this barn is provided with two silos, two watering tanks, and a liquid-manure cistern, the size and location of which are clearly indicated in the ground-floor plan.

43. Barn of the Iowa Agricultural College.—A general view of the silo end of the model dairy barn in use on the dairy farm of the Iowa Agricultural College is shown in Fig. 44. As illustrated in the ground plan, which is shown in Fig. 45, this structure is **L**-shaped. The main part is used for box stalls, calf pens, an office, and storage rooms, and the ell for stabling the cows, stalls being provided for fifty-one cows. It will be seen from the ground plan that cows in the stalls will face away from one another, and that the two manure gutters are near the center of the barn. A manure carrier runs along the center alley and to the outside, as shown in Fig. 44. The cow barn is only one story in height, but it is provided with a monitor roof and a window arrangement that makes it particularly well lighted. Hay and feed are stored on the second floor of the main structure. On the west side of the barn is a semi-detached milk house, not shown in the figures.

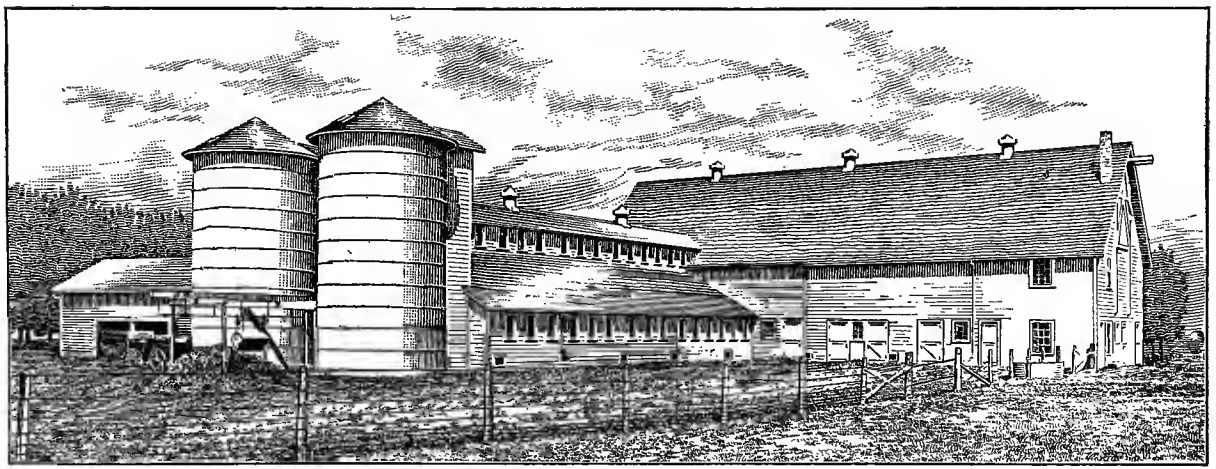


FIG. 44

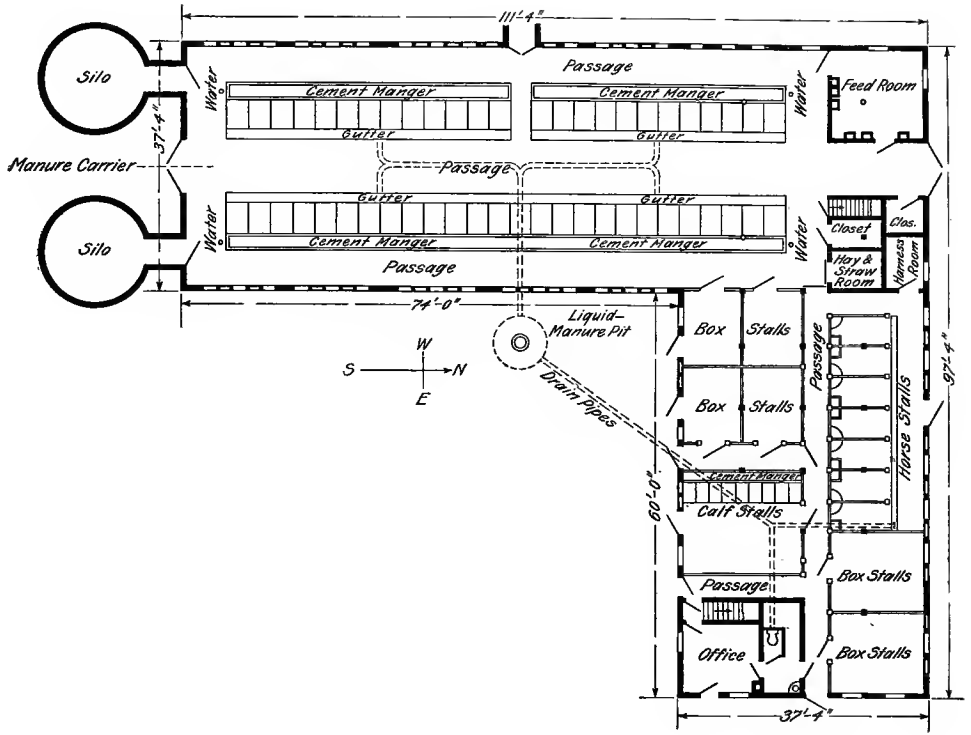

111'-4"
Silo
Water
Cement Manger
Gutter
Passage
Feed Room
37'-4"
Manure Carrier
Silo
Water
Cement Manger
Gutter
Passage
Closet
Clas.
Hay & Straw Room
Harness Room
74'-0"
Liquid-Manure Pit
W
S
N
E
Drain Pipes
Box Stalls
Box Stalls
Passage
Horse Stalls
97'-4"
Cement Manger
Calf Stalls
60'-0"
Passage
Box Stalls
Office
Box Stalls
37'-4"

FIG. 45

ROUND AND POLYGONAL BARNS

ROUND BARNS

44. Advantages of Round Dairy Barns.—The **round dairy barn,** provided it is properly constructed, undoubtedly has several advantages over rectangular structures. One of the chief of these advantages is that a round barn requires less lumber for its construction than does a rectangular barn of the same capacity, some authorities claiming that this difference amounts to as much as 30 or 40 per cent. in favor of the circular construction. Another advantage is the convenience of distributing feed to the cows and of removing manure from the barn. In a round barn, the silo, the hay-storage space, and the grain room are usually located in the center of the building. This arrangement makes it possible to distribute feed with no unnecessary retracing of steps, the feeder simply starting at one point and working around in a circle until he returns to the starting point. There is, of course, a corresponding saving in cleaning out the gutters behind the cows. Further advantages are that the silo can be enclosed within the barn, thus making it unnecessary to weatherproof the outside of the silo, and that an open, unobstructed space is available for the storage of hay and straw. Round barns are also stronger than rectangular barns, and consequently resist the racking effects of high winds better than do barns of the latter construction.

45. Disadvantages of Round Dairy Barns.—Some dairymen object to the round barn for the reason that additions cannot easily be made when the dairy herd has increased to the point where it requires more barn room. It is, however, possible to obviate this difficulty by including a second floor in the building and using this second floor for other purposes until the dairy herd becomes large enough to require more barn room. Another disadvantage of round barns is that box stalls do not fit into them as conveniently as they do in

rectangular barns. However, as will be seen from the illustrations of round barns that follow, it is possible to provide a satisfactory arrangement of box stalls.

Perhaps the chief objection to round barns, especially the early type of round barn, is the straight roof. A roof of this kind requires numerous supporting posts, which greatly encumber the space in the interior that should be left free. This objection is entirely obviated in the newer types of roofs, which are self-supporting. In addition to leaving the interior free from supports, this style of roof construction has the advantage of greatly increasing the mow capacity.

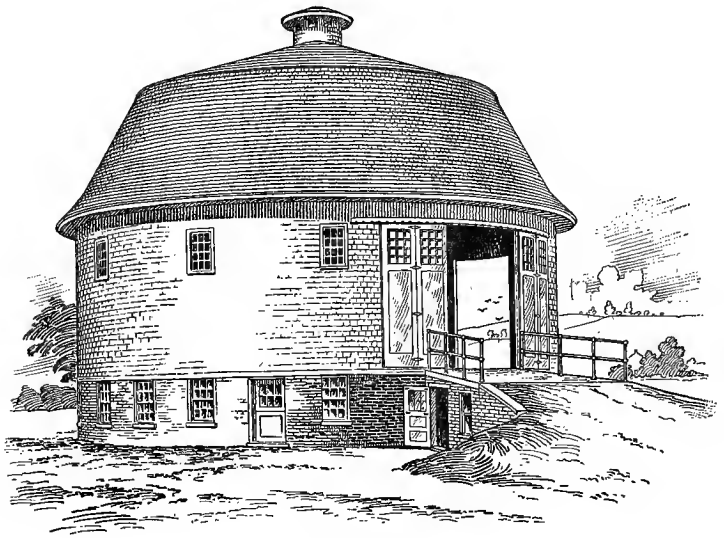
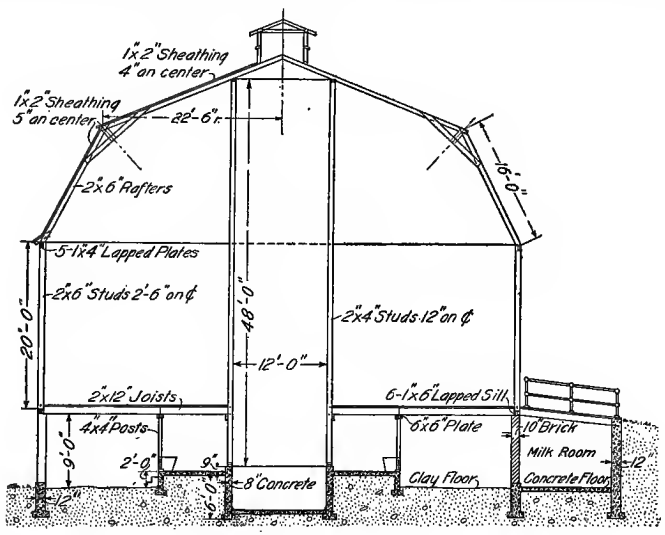


FIG. 46

46. Round Barn of the University of Illinois.—In Fig. 46 is shown a general view and in Fig. 47 a sectional view of the round dairy barn in use at the University of Illinois. In the sectional view are specified the dimensions of both the barn and the principal timbers used in its construction. In Fig. 48 are shown a ground-floor plan and a plan of the joists. It will be seen from the ground-floor plan that there are mangers for twenty-eight cows in a single circular row facing the center of

the barn. A stanchion is provided for each manger, but the cows are confined in the stanchions only at feeding and milking time. At other times, the cows are turned loose in the open space between the mangers and the barn wall. By means of gates, as shown in the ground-floor plan, it is possible to close up a part of this area, thus making temporary box stalls. The floor in this circular area is of clay, and it has been found satisfactory as long as it is kept well covered with litter. The fact that the cows are loose in the enclosure most of the time makes the conditions here somewhat different from those in the usual



Section of Round Barn

FIG. 47

barn, where a clay floor would likely be objectionable. The plan of joists shows also the plan for laying the flooring as well as the two bridges by which loads may be taken into or out of the second floor of the barn. On the ground floor beneath one of these bridges, as shown in the ground-floor plan, is located a milk house that has a concrete floor and is fitted with a concrete cooling vat. The King system of ventilation is used in this barn, and, as indicated in the ground-floor plan, the hay

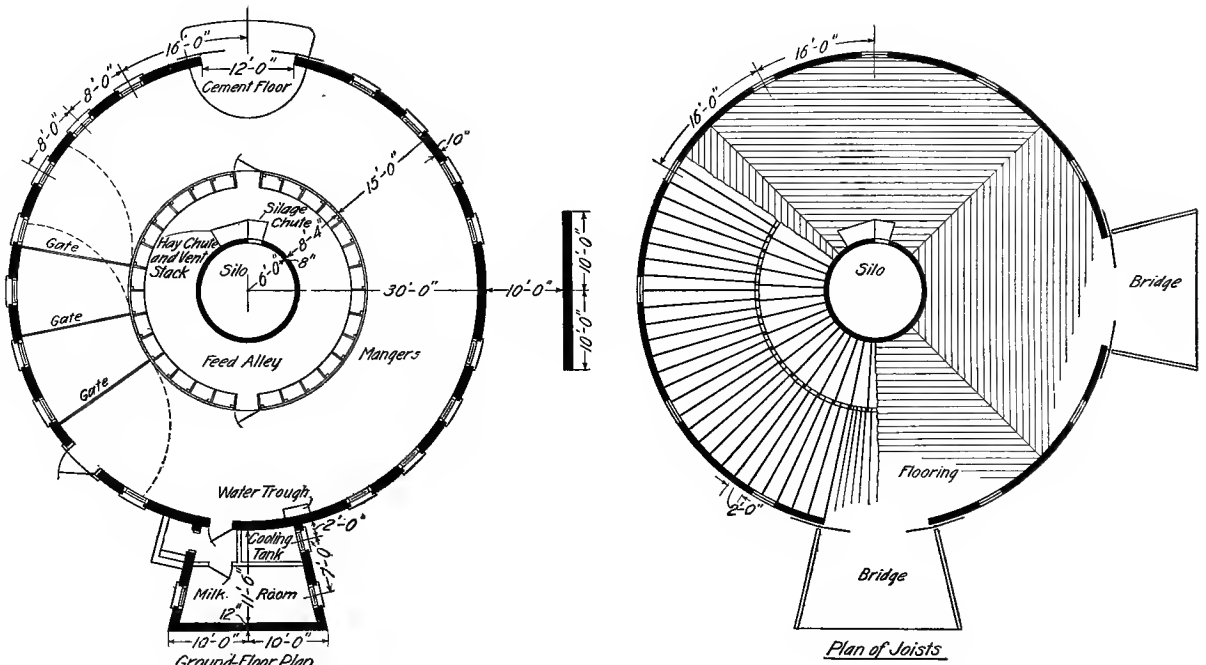

16'-0"
12'-0"
Cement Floor
8'-0"
8'-0"
8'-0"
10"
15'-0"
Silage Chute
Hay Chute and Vent Stack
Gate
Gate
Gate
Silo
6'-0"
8"
8"
30'-0"
10'-0"
10'-0"
10'-0"
10'-0"
Feed Alley
Mangers
Water Trough
Cooling Tank
2'-0"
7'-0"
Milk Room
12"
10'-0"
10'-0"
Ground-Floor Plan
16'-0"
16'-0"
Silo
Bridge
Flooring
2'-0"
Bridge
Plan of Joists

FIG. 48

chute is made to serve as a ventilating stack for the removal of foul air from the barn.

If the stall arrangement illustrated in Fig. 49 were used in this barn, forty cows could be accommodated. This increased capacity is secured by simply setting the row of stanchions farther from the center of the barn, thus utilizing for stalls some of the space that in the preceding plan is given over to exercise room in which the cows are allowed to run loose. If the plan shown in Fig. 49 were employed, the size of the silo

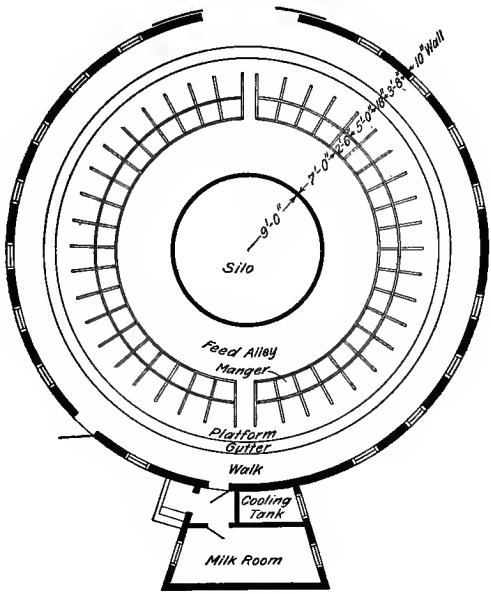


FIG. 49

could also be increased, as shown, so as to provide additional storage for silage.

47. Round Barn for Seventy-Six Cows.—A floor plan for a round dairy barn that is 80 feet in diameter and will stable seventy-six cows is shown in Fig. 50. The stalls for the cows are in two circular rows and face away from each other. Between the rows of stalls is a driveway, the entrance to which

is on one side of the barn and the exit on the other. This driveway is sufficiently wide to accommodate a manure spreader or a wagon, as shown by the dimensions marked on the plan. These dimensions also show the widths of the silo, the feed alleys, and the platforms. If desired, framework and an arrangement of the second floor similar to those for the barn described in the preceding article may be employed in constructing a round barn having a first-floor plan like the one shown in Fig. 50.

48. Round Barn for 105 Cows.—A floor plan for a round dairy barn of somewhat larger capacity than the preceding is

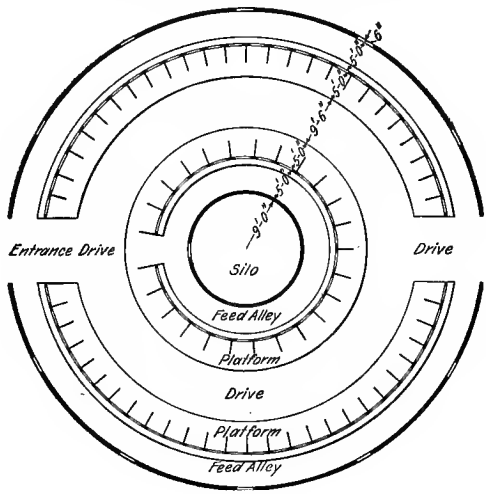


FIG. 50

illustrated in Fig. 51. This barn is 90 feet in diameter and, as in the preceding case, the important dimensions are indicated on the plans. It will be noticed that in this plan the cows face one another; nevertheless, if desired, this arrangement could be reversed and made similar to the plan shown in Fig. 50. To some extent, the increased capacity of the barn in Fig. 51 is due to the fact that only one entrance is provided. Owing to the difficulty that may be encountered in driving a wagon

or a manure spreader behind the stalls of a barn constructed according to this plan, a manure carrier running on an over-

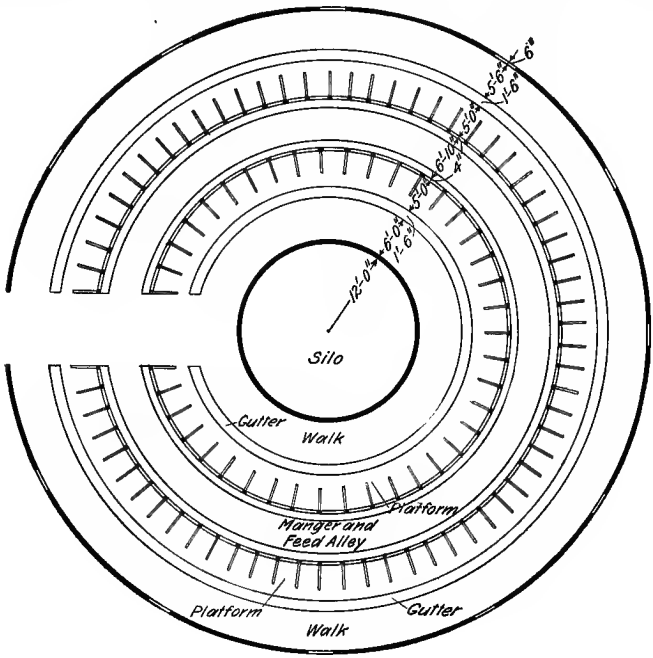


FIG. 51

head track will undoubtedly be found the most satisfactory means of removing manure from the barn.

POLYGONAL BARNS

49. The polygonal form of construction is sometimes followed in building dairy barns. The usual plan is to make the building eight-, twelve-, or sixteen-sided, with a silo in the center. The arrangement of stalls may be in circles, similar to the plan followed in round barns, in polygons, or in straight lines extending across the barn.

The polygonal barn has been criticized adversely by some authorities, and in some respects it is doubtless inferior to both

the square and round forms. It is claimed that a polygonal barn has the disadvantages of both of the other forms, is more expensive to build, and is more difficult to make strong and rigid, the latter defect being in a large measure due to the fact that the siding cannot be made to run around the structure so as to form hoops to bind it together as is possible in building round barns. Each side of a polygonal barn must be sided separately, and special precautions must be taken to tie the sides together. Even when these precautions are taken, it is claimed that polygonal barns are liable to be thrown out of

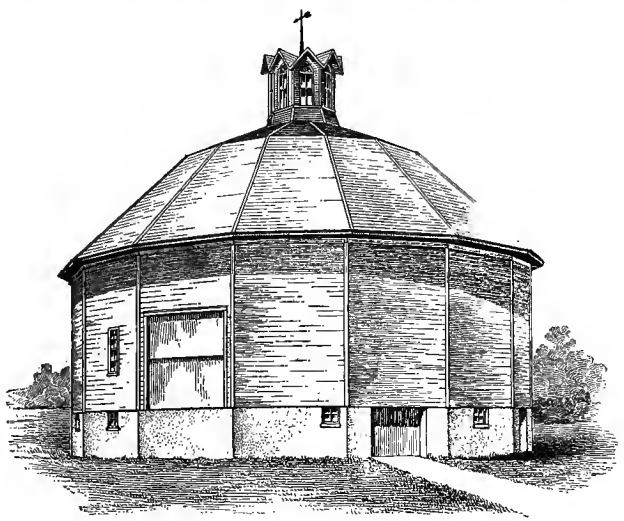


FIG. 52

plumb by strong winds. The framework for a barn of this form must be heavier than that required for a round barn, thus making the former more expensive, in regard to both the cost of material and the cost of erection.

50. Polygonal Barn for Eighty-Eight Cows.—An exterior view of a sixteen-sided dairy barn capable of housing eighty-eight cows is illustrated in Fig. 52. The foundation and the wall of the first floor are of cement, and the remainder of the structure is of wood. The floor plan of this barn is shown in

Fig. 53, from which it will be seen that the mangers are arranged in straight lines and that box stalls, calf pens, a feed room, and a wash room are provided. This barn contains no silo, but by sacrificing a few cow stalls in the central space this feature could easily be provided for. The large door on the second floor, as shown in Fig. 52, affords an opening through which hay and grain may be taken into the barn.

51. Polygonal Barns for Seventy Cows.—In Fig. 54 is shown the floor plan of a sixteen-sided barn and in Fig. 55 a

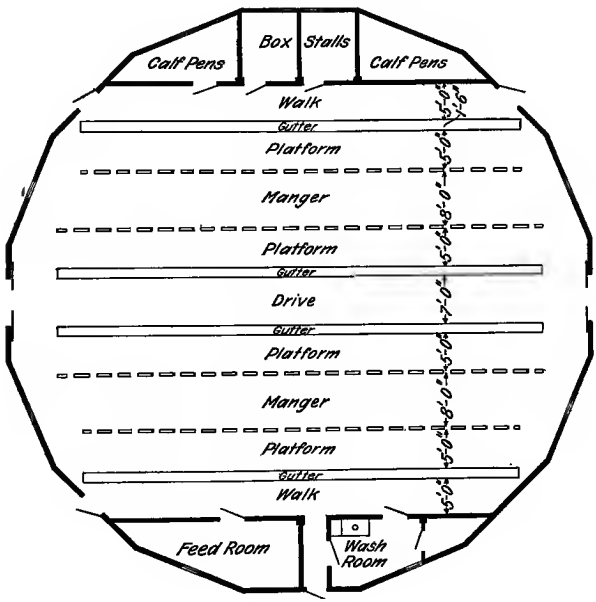


FIG. 53

similar plan of an eight-sided barn, each of which has sufficient stalls for seventy cows. The stalls in each barn are placed so that the cows will face away from each other, about the only difference being that in Fig. 54 the stalls are arranged so as to follow the polygon shape of the barn, while in Fig. 55 they are arranged in circles. The barn shown in Fig. 54 has two entrances and no silo, and the one in Fig. 55 has a silo and only one entrance.

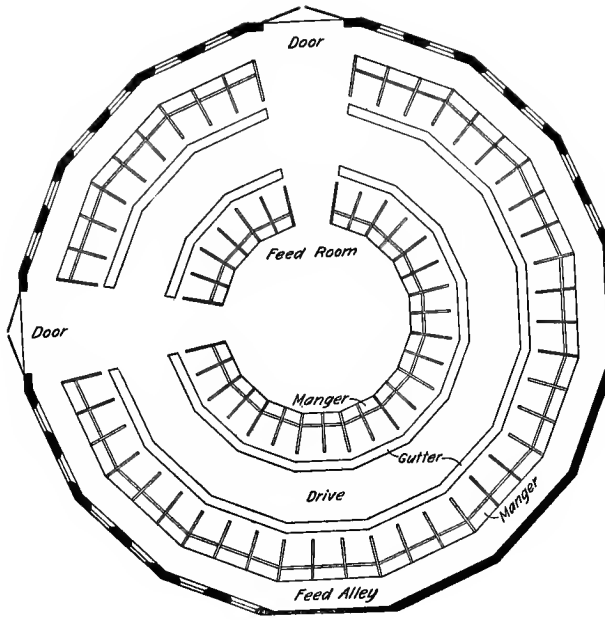

Door
Feed Room
Door
Manger
Gutter
Drive
Manger
Feed Alley

FIG. 54

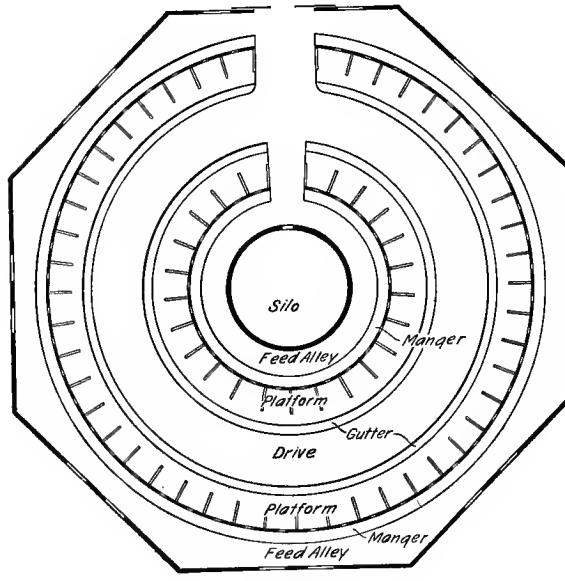

Silo
Feed Alley
Manger
Platform
Gutter
Drive
Platform
Manger
Feed Alley

FIG. 55

BASEMENT BARNS

52. Rectangular, round, and polygonal barns are frequently built on inclined ground in such a manner that a part of the structure is surrounded by a bank of earth. Barns constructed in this manner are known as **basement** or **bank, barns.** Such barns are warm in winter and cool in summer, and while these conditions have made them popular, there are several objections to them for housing dairy cows. One great objection is that barns of this construction are likely to be insufficiently lighted and poorly ventilated. Another objection is that the earth

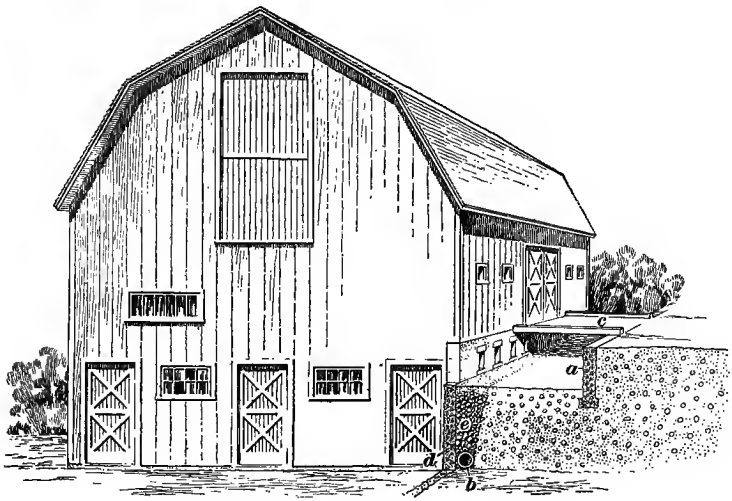


FIG. 56

walls tend to make the barn damp. However, it is possible to obviate these objections by proper construction, in which case a bank barn may be entirely satisfactory for a dairy herd.

53. A good method of admitting light to a basement, or bank, barn is illustrated in Fig. 56. As shown, a shallow excavation is made in the earth bank for a distance of 8 or 10 feet from the barn wall. A low wall *a* is laid at the outer edge of the excavation, which arrangement permits numerous small windows to be placed on the bank side of the barn. If it is

necessary to have a driveway leading into the second floor of a barn built in this manner, a bridge *c* may be constructed over the excavation between the wall *a* and the barn wall. Fresh-air intakes similar to the form shown in Fig. 12 (*d*) will provide ventilation facilities for a bank barn of this kind, and dampness may be prevented by laying drain tile as shown at *b*. As a further precaution against the seepage of moisture through the wall of the barn, it is advisable to place from 12 to 15 inches of gravel or crushed stone between the wall *d* and the earth

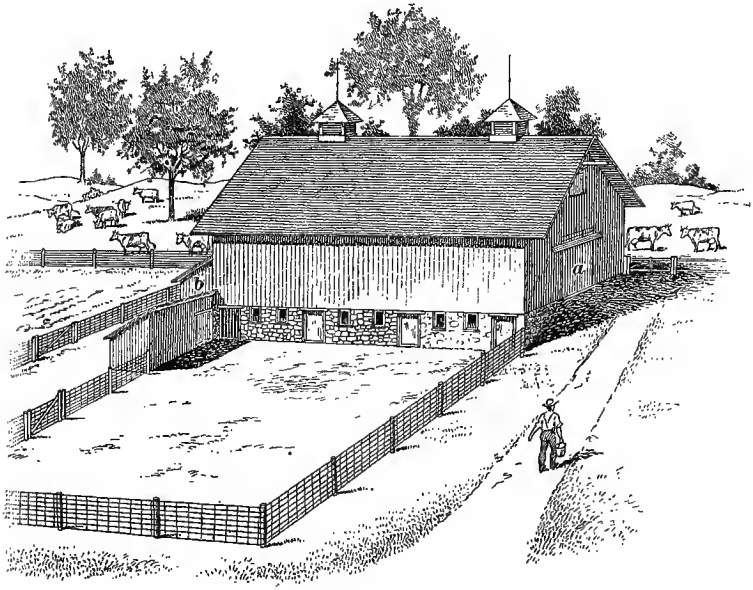


FIG. 57

bank, as shown at *e*. This will allow ground water to descend to the lower ground level and thus help to keep the wall dry.

54. Rectangular Basement Barn.—A rectangular bank barn that will accommodate from forty to fifty cows is shown in Fig. 57. The stone basement is 9 feet high, and the barn proper is 80 feet long and 28 feet wide, as indicated in Fig. 58, which shows the ground-floor plan as well as a sectional view of the barn. As will be seen in the floor plan, the stalls are

placed so that the cows face one another. The feed room and milk room, as shown at *b*, Fig. 57, are in the form of lean-to

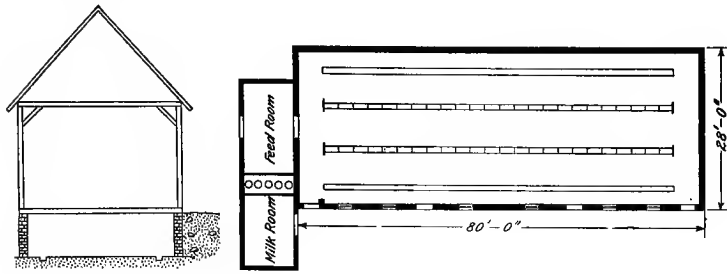


FIG. 58

sheds. The feed room opens into the barn, for convenience in distributing feed to the mangers, but the milk room has no direct connection. The cows enter the barn through doors in the basement, and hay and other feed are taken into the barn from the ground level through the door *a*.

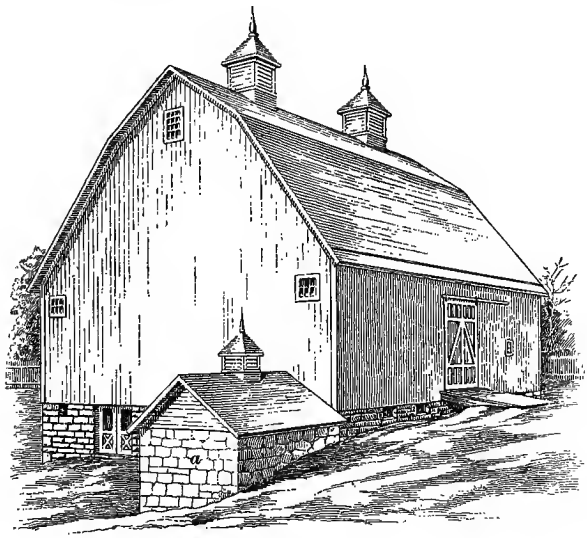


FIG. 59

55. Basement Barn for Seventy-Two Cows.—In Fig. 59 is shown a basement barn having a capacity of seventy-two

cows. The foundation and first-floor wall are of stone and the structure is of wood. The detached milk house shown at *a* is built of the same materials. Small windows are provided

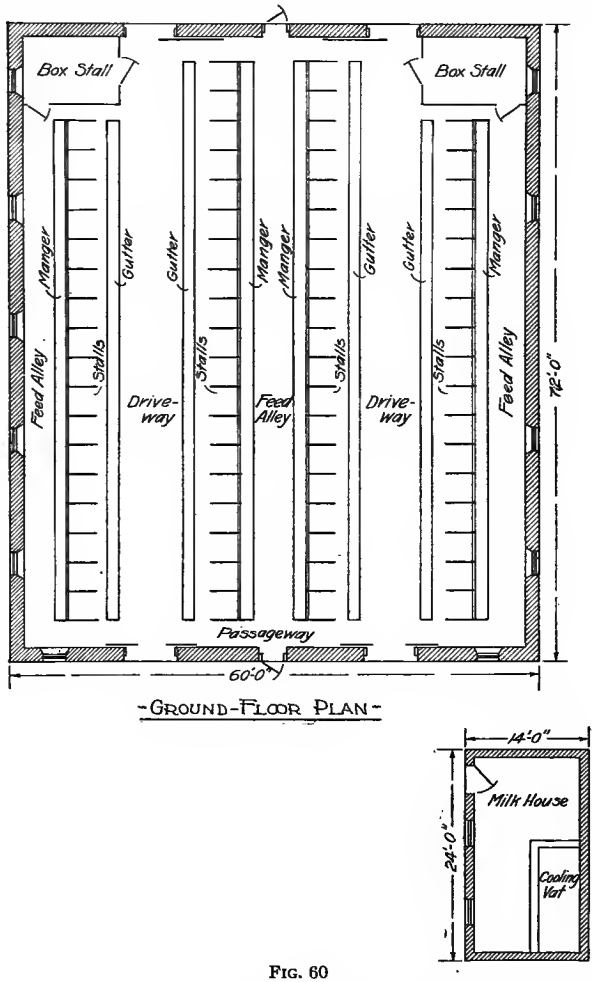


FIG. 60

on the bank side of the barn for admitting light to the basement. Fig. 60 shows the ground plan of this barn, from which the stall arrangement and other details will be seen. The dimensions of the barn are 60 ft. × 72 ft., and those of the milk house

14 ft. × 24 ft. The second floor of the barn has ample capacity for the storage of hay and feed, and is easily accessible from the ground level, as will be seen by the location of the sliding door in Fig. 59 and the bridge approaching it.

56. Bank Barn of the Tennessee Experiment Station.—At the Tennessee Experiment Station there is in use a bank dairy barn that has been found to be extremely satisfactory. It includes some features that would not be required in an ordinary dairy barn, but the plan could be easily modified to suit individual requirements. An elevation of this barn is shown in Fig. 61. The large number of windows on the ground floor

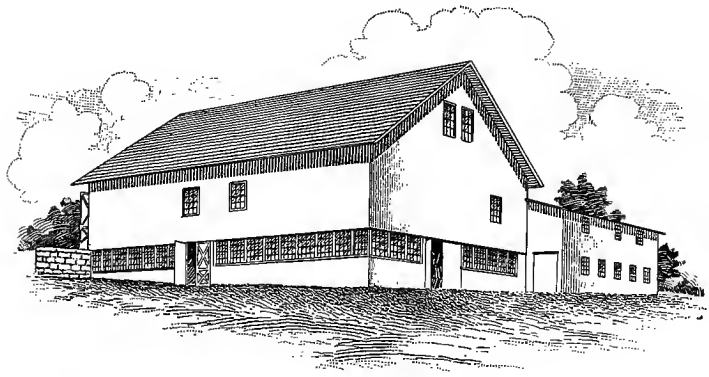


FIG. 61

are particularly desirable, because they admit plenty of light to the room in which the cows are kept.

Plan views of the ground floor and second floor of this barn are illustrated in Fig. 62. As shown, there are three rectangular silos at one end of the barn conveniently near the feed rooms on both floors. The space on the first floor utilized for a stock-judging room could, if desired, be used for calf pens or for additional cow stalls; also, the experimental seed room on the second floor could be utilized as an additional hay-storage room or it could be employed for storing implements. The addition shown at the right in Fig. 61 contains stalls for bulls and calves on the ground floor and storage room on the second floor.

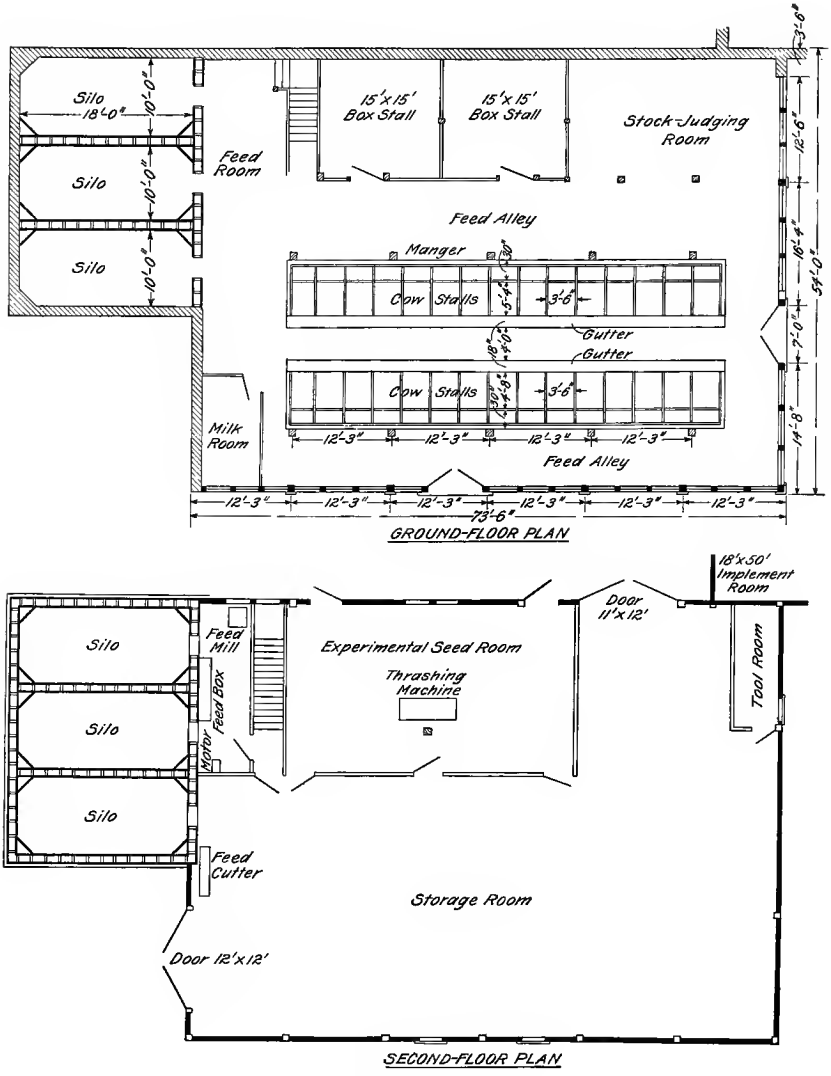

Silo
18'-0"
10'-0"
Silo
10'-0"
Silo
10'-0"
Feed Room
15'x15' Box Stall
15'x15' Box Stall
Stock-Judging Room
Feed Alley
Manger
Cow Stalls
3'-6"
Gutter
Gutter
Cow Stalls
3'-6"
Milk Room
12'-3"
12'-3"
12'-3"
12'-3"
Feed Alley
12'-3"
12'-3"
12'-3"
12'-3"
12'-3"
12'-3"
73'-6"
3'-6"
12'-6"
18'-4"
7'-0"
14'-8"
54'-0"
GROUND-FLOOR PLAN
18'x50' Implement Room
Door 11'x12'
Silo
Silo
Silo
Feed Mill
Feed Box
Motor
Experimental Seed Room
Thrashing Machine
Tool Room
Feed Cutter
Storage Room
Door 12'x12'
SECOND-FLOOR PLAN

FIG. 62

BREEDS OF DAIRY CATTLE

DAIRY TYPE OF CATTLE

1. Description of Dairy Type.—The majority of animals of all breeds of cattle that are noted for the secretion of large quantities of milk have a peculiar and distinct conformation, commonly termed the **dairy conformation,** and animals that possess this conformation are said to be of the **dairy type.** The most distinguishing features of the dairy type are the triangular, or wedge, shape of the body and the lean frame. This conformation is decidedly more marked in the females than in the males.

When an animal, especially a cow, of the dairy type is viewed from the side, the front, or from above, the general outline of the body will appear wedge-shaped. This conformation is illustrated in Fig. 1, which shows two views of a dairy cow. In (*a*) is shown a profile view, and in (*b*), a combined front and top view. Viewed from the side, the top and the bottom lines of such an animal are seen to diverge from the front of the body toward the rear, and to converge from the rear of the body toward the front. The degree of divergence varies greatly in different animals; it may be so little as to be barely perceptible, or it may be distinct and well marked. In an animal that would be recognized from the side as being typically wedge-shaped, the top and bottom lines would meet at a point in front of the animal about four or five times the length of its body. The top line diverges because the animal is lower at the shoulder than it is at the hips; the difference in height at these two points ranges from ½ inch to 1½ inches. The divergence of the bottom line is

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ENTERED AT STATIONERS' HALL, LONDON

ordinarily due to a large abdomen, and is, of course, greatly enhanced when the animal has a large and well-filled udder. Besides appearing wedge-shaped from the side, a cow of the dairy type is also wedge-shaped as viewed from the front; that is, the portion of the body at the region of the hips and abdomen is wider than that at the shoulders. A cow of the dairy type is wedge-shaped as viewed from a position above her because the backbone is thinly covered with muscular tissue, and the sides slope outwards and downwards toward the widest part of the abdomen.

2. In addition to being wedge-shaped, the characteristic dairy form is angular, or lean; that is, it has a comparatively thin covering of muscular tissue. The shoulders are thin and the ridge of the shoulder blade is prominent. The ribs are thinly covered with muscle, particularly on the upper part close to the backbone. The loin is broad and flat but bony, and the thighs are thin, flat, and incurved at the rear as viewed from the side. That the angularity is due to a lack of muscular development rather than to a lack of fatty tissue is shown by the fact that cows of the dairy type frequently take on fat when far advanoed in the period of lactation or when completely dry.

The characters of the dairy type of animal that have just been described are the most striking, but there are numerous minor characters that distinguish this type from the beef type. Among these are: leanness of head, breadth of muzzle, and thinness of neck. The dairy type of cow also has a distinctly feminine appearance.

3. Relation of Dairy Conformation to Milk Secretion. For many years dairymen have observed that the dairy conformation and the secretion of large quantities of milk have a close connection, but the reason for this correlation of the two is not well understood. It is true that some cows of a distinctly beefy type produce equally as much milk as do cows of the strictly dairy type, but this is by no means common.

Doubtless the close association of milk secretion with dairy conformation is an economic provision of nature. As the dairy cow has been developed primarily for the production of milk, any excess of flesh or bone would tend to divert that

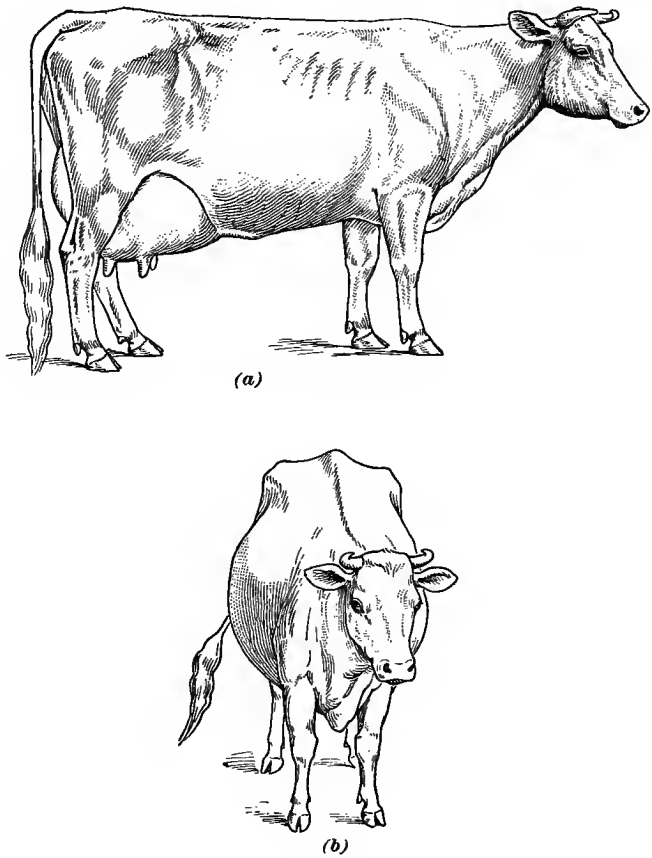


FIG. 1

function. The large muzzle and abdomen associated with the dairy conformation are capable of taking care of maximum quantities of feed, and with the various muscular tissues reduced in size to the minimum, a large percentage of the feed can be utilized for the formation of milk.

DAIRY BREEDS

JERSEY CATTLE

4. Origin and Development of Jersey Cattle.—The **Jersey breed** of cattle originated on the island of Jersey, one of a group of small islands lying in the English Channel, near the coast of France. Little is known of the ancestry of the breed, but it is believed that its progenitors came from the neighboring mainland of France. Beginning with a foundation stock that was rough and not especially noted for milk secretion, the farmers of the island have developed the Jersey breed to its present state of excellence by intelligent care and management. In the latter part of the 18th century, a disease called rinderpest, known also as cattle plague, ravaged the cattle of the western part of Europe, and, as a precaution against the disease, the people of Jersey prohibited the importation of live cattle into the island, even from the near-by island of Guernsey; this prohibition has continued to the present time. Thus, for more than a century, native Jersey cattle have been bred without any admixture of outside blood.

5. Importation of Jerseys Into North America.—About 1850, Jersey cattle in small numbers were first imported into North America. It was not until about 1870, however, that they became numerous on this continent. Since that time the number has constantly grown larger, both by importations from Jersey and by the natural increase of the animals. The larger part of the Jersey stock of North America is so-called home bred, that is, descended from animals whose ancestors for several generations have been in America. Between 1880 and 1895, comparatively few Jersey animals were imported; since the latter year a large number have

FIG. 2

FIG. 3

been brought over. These recent importations and their descendants have come to be spoken of as being of the *island type* to distinguish them from the descendants of animals of earlier importations, which are referred to as being of the *American type*. The chief difference between animals of the two types is that those of the island type are somewhat smaller, finer, and more delicate than those of the American type. It is believed by many breeders of Jersey cattle that the attempt to segregate the breed into these two types is not a wise one, and is likely to work injury rather than benefit to the breed as a whole. At least, under such conditions, there cannot be a concerted effort toward improvement of the breed.

6. Description of Jersey Cattle.—Jersey cattle are characterized by small to medium size. The official score card of the breed calls for from 800 to 1,000 pounds as the weight of a mature cow. The bulls weigh considerably more than this, their weight usually ranging from 1,200 to 1,800 pounds when they are mature.

In Fig. 2 is shown a typical Jersey cow, and in Fig. 3 is shown a bull of the same breed. The Jersey cow has the characteristic dairy form well developed, and there are few cows of the breed that are not distinctly wedge-shaped as viewed from any angle. The bulls, also, have the dairy conformation to a marked degree.

A prominent characteristic of the Jersey form is the tendency of the bones to be short and curved. For instance, the face is short and usually dished; the hind legs are crooked; and in many cases there is more or less of a tendency for the back to depart from a straight line, as exhibited by the animal illustrated in Fig. 3.

In color, the Jersey is variable. The typical color, however, is fawn or gray shading to black at the extremities, with a black muzzle, a black tongue, and a black switch at the end of the tail. As a rule, there is a ring of light-colored hair immediately about the muzzle. In some animals, particularly in bulls, the gray shades to black over the whole body, and in others the fawn color deepens to almost a red.

A considerable proportion of Jerseys are marked with more or less white. Such animals are known as broken colored. In former years, the Jersey breeders of England and America showed a distinct preference for animals of solid color, thus discriminating against those of broken color, but in recent years the color line has not been closely drawn by breeders of these countries.

7. Jersey cattle are often thought to be delicate and lacking in vigor. This may be largely due to their small size. That there is no inherent lack of vigor in the breed is shown by the fact that from Jersey, which is only about 60 square miles in area, Jersey cattle have spread in North America from far up in Canada to Texas and from Maine to California within a little more than 50 years, and in nearly every locality where they have been introduced their numbers have constantly increased.

The Jersey is mild and tractable, but rather nervous, and under ill treatment often becomes wild and unmanageable. Jersey bulls frequently show much irritability of temper, particularly at about 2 or 3 years of age, but with proper care such animals can be managed and handled without difficulty.

The Jerseys produce a moderate quantity of milk, which contains a high percentage of butter fat. Normal Jersey milk contains about 5 per cent. of butter fat; frequently the per cent. is less and frequently greater, in some cases rising as high as 7 per cent. In quantity of butter fat produced in a year, the Jersey ranks as one of the leading dairy breeds.

8. Registry of Jersey Cattle.—The interests of the Jersey breed in North America are fostered by the American Jersey Cattle Club. This organization publishes a herd book under the title, "Herd Register of the American Jersey Cattle Club." Animals that have been imported from the island of Jersey, or those directly descended, through both sire and dam, from such animals are eligible for registration in this herd register. In Jersey and various other countries, organizations for the exploitation of the breed are maintained.

The advanced *register of merit* of the American Jersey Cattle Club, which was inaugurated in 1903, as applied to cows, is simply an additional register for animals whose production of milk and of butter fat, as determined by the Babcock test, is sufficient to entitle them to a place of distinction in the records of the breed. This system of advanced registration also guarantees to the public that records claimed for individual animals are authentic. A Jersey cow is admitted to advanced registration if she meets any one of certain requirements, provided that the production of milk or butter shall be authenticated by a representative of a state, provincial, or national experiment station or agricultural college, or by a tester appointed by the president or by the executive committee of the American Jersey Cattle Club. The requirements for admission to the register of merit are frequently changed.

GUERNSEY CATTLE

9. Origin and Development of Guernsey Cattle.—The **Guernsey breed** of cattle originated on the island of Guernsey, which, like Jersey, is one of the Channel Islands. The soil and climate of the island are similar to those of Jersey, and the cattle, it is believed, originally came from France, the country from which the ancestors of the Jerseys are believed to have come. A law prohibiting the importation of live cattle has existed in Guernsey, as in Jersey, for over a century, and thus all the cattle of the island are free from foreign blood.

When the first exportations of Jersey and Guernsey cattle from the Channel Islands were made to England about the middle of the 19th century, no attempt was made to distinguish between the two breeds, the name Alderney being applied to both. This name was derived from that of the island of Alderney, which affords the best harbor on the Channel Islands for ships clearing from the islands. Thus, all products of the islands came to be indiscriminately spoken of as Alderney products. The name Alderney, as applied to a breed of cattle, has now fallen into almost complete disuse.

10. Importation of Guernseys Into North America.—Guernsey cattle were introduced into North America at about the time the first Jerseys were imported. At first the two breeds were more or less confused in the minds of American breeders and interbreeding was practiced in many instances. It was not long, however, until the two were differentiated, and for many years there has been absolutely no admixture of these breeds in pure-bred herds.

The number of Guernseys that have been imported into North America, as compared with the number of Jerseys, is small. The island of Guernsey is much smaller than that of Jersey and has proportionately fewer animals. For this reason fewer Guernseys than Jerseys are exported. Guernseys are found in all parts of the United States and Canada where dairy cattle are kept, but they are particularly numerous in Southeastern Pennsylvania, New Jersey, Massachusetts, Wisconsin, New York, and Iowa.

11. Description of Guernsey Cattle.—Guernseys are of a larger size than the Jerseys, although the animals, as a whole, cannot be characterized as large. Mature cows will seldom weigh more than 1,200 pounds, and occasionally weigh less than 1,000 pounds. The official score card of the breed calls for a weight of 1,050 pounds for a cow 4 years old or over, and 1,500 pounds for a bull of the same age.

In Fig. 4 is shown a Guernsey cow of the desired conformation. A typical bull of the same breed is shown in Fig. 5. In form, Guernseys have the characteristic wedge shape and the spareness and angularity of conformation of the dairy type, although in some animals there is a slight tendency to beefiness and to thick, heavy shoulders. This latter conformation is more frequently seen in bulls, although a number of the cows are thicker through the shoulders than is desirable. Although geographically the Guernseys are closely related to the Jerseys, they are distinct from them in form. The bones of the Guernsey are much straighter than those of the Jersey and are inclined to be somewhat longer.

12. The characteristic Guernsey color is fawn and white. Breeders of fancy stock prefer the colors to be about equally distributed and in rather large blocks or patches. Occasionally, Guernseys are seen with no white at all; and the number of animals of this breed in which the white color includes more than two-thirds of the whole surface is comparatively small. The shade of fawn varies from very light to very deep or dark, almost red, the shade most preferred being usually described as orange fawn. Whatever the shade of fawn, there should be no black hairs, especially in streaks or patches, forming a brindled appearance. Where such miscolorations occur, they are apt to be on the face, neck, or shoulders, and although they do not necessarily indicate impurity of blood, they do show a lack of careful breeding and selection.

A characteristic of the Guernseys that has considerable influence in affecting their color is a profuse secretion of yellow coloring matter, which pertains to the whole skin, but may be seen especially on those parts where the skin is bare or only thinly covered with hair, such as in the ears, about the muzzle, in the fore flank, and about the vulva. In the best specimens, this secretion is of a deep golden-tan color shading into orange-yellow. This color extends also to the hoofs and horns, giving these, especially in choice specimens, an amber appearance. The muzzle of the Guernsey should be of a clear flesh color tinged with orange, like the skin on the adjacent bare parts. Frequently it is mottled, and in occasional cases it is dark or almost black. Although milk production is not affected in any way by it, an animal with this latter coloration of the muzzle is looked on with great disfavor by most breeders and is usually rejected or sold at a much lower price than an animal no better in general conformation and qualities but without this objectionable coloring.

13. Doubtless due to their slightly larger size, it is claimed by some breeders that Guernseys are possessed of more vigor than Jerseys, but this point is strongly disputed by admirers of the Jersey breed. Although they are not lacking in vigor,

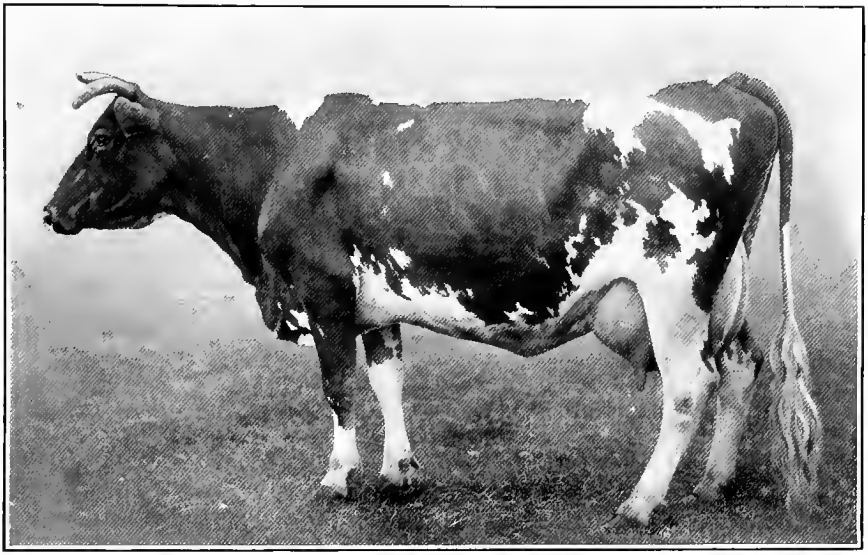


FIG. 4

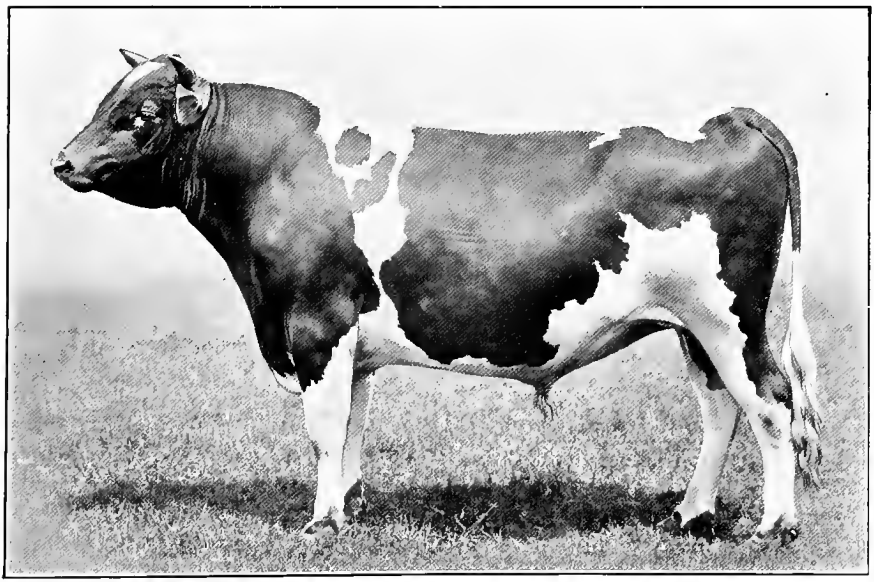


FIG. 5

it should not be claimed for Guernseys that they are naturally more vigorous than Jerseys. Individual animals of both breeds may exhibit exceptional vigor, but, as a whole, the two breeds are much on a par in this respect.

In temperament, the Guernsey is mild and tractable and not so nervous as the Jersey. Also, the males of this breed are not so likely as those of the Jersey breed to become unruly when well advanced in age.

14. Guernseys do not produce large quantities of milk, but their milk is ordinarily of about the same quality as that of the Jerseys, varying from $4\frac{1}{2}$ to $6\frac{1}{2}$ per cent. of butter fat. The milk, cream, and butter of the Guernseys are of a higher color than the similar products of any other breed, and to a large extent this is an advantage, since these products, especially butter, are frequently artificially colored. The color is so marked that for many markets Guernsey butter need not be artificially colored at any time of the year, and the milk from fresh cows on grass is sometimes so highly colored that the butter is of too deep a tint for the most critical markets.

15. Registry of Guernsey Cattle.—The herd book of the Guernsey cattle in North America is maintained by the American Guernsey Cattle Club, which was organized in 1877 for this purpose. Animals imported from Guernsey or direct descendants of imported Guernseys are eligible to registration in the herd book.

Like most similar organizations of breeders of dairy cattle, the American Guernsey Cattle Club has instituted an advanced registry for exceptionally good individuals. This system was put in operation in 1901.

HOLSTEIN-FRIESIAN CATTLE

16. Origin and Development of Holstein-Friesian Cattle. The **Holstein-Friesian breed** of cattle originated in the provinces of North Holland and West Friesland in the Kingdom of the Netherlands. The name Holstein, which is commonly given to this breed, is a misnomer so far as any geographical significance is concerned, as the Duchy of Schleswig-Holstein, from which the name was derived, is a province of the German Empire and is at some distance from the two provinces in which the cattle originated. A more appropriate name for these cattle would be Dutch. The matter of the name was a subject of long controversy in the early history of the breed, and the hyphenated name, Holstein-Friesian, was finally officially adopted as a compromise. The common name of Holstein is simply a shortening of the official name.

North Holland and West Friesland, the home of Holstein cattle, are fertile provinces immediately surrounding the Zuyder Zee. In both of these provinces much of the land lies below the level of the sea, and has been reclaimed by diking and draining. The dairy industry in these provinces has been highly developed for many years, and more attention has been given to the breeding and quality of the cattle than in any of the surrounding countries, although similar cattle are found in Southern Holland, in parts of Belgium, and in several provinces of Northwestern Germany, notably East Friesland.

Much of the improvement in the quality of Holstein-Friesian cattle has been brought about in the last century, and this has been due, in a large measure, to the force of circumstances. The Dutch farmer occupies land that is valuable, and as he depends on his dairy products for his revenue, it is essential that only the most productive animals be kept. This condition, which has been operative for more than a hundred years, has resulted in the selecting of the superior and the weeding out of the inferior animals. It has resulted in an increase in the size of the cattle, which were large to begin with, and an increase in milk production. Also, cer-

tain characters, notably those of form and color, have been firmly fixed.

17. Importation of Holsteins Into North America.—Holsteins were first introduced into the United States about 1860, but only in small numbers and by a few men. Attention was first drawn to them on account of their large milk production, and at first little attention was paid to the quantity of butter fat they produced. They increased rather slowly in numbers for a time, but, beginning about 1880, they gained rapidly in public favor and at the present time are numerous. By far the largest number of all animals brought from Holland to North America were imported between 1875 and 1885; since that time, importation has practically ceased. Although the Holsteins have a wide range of adaptability, they have not spread in North America so rapidly to the south and the extreme west as have the Channel-Island breeds. They are found most numerously in the distinctly dairy districts, and in those localities where milk is produced largely for direct consumption.

18. Description of Holstein-Friesian Cattle.—Holstein cattle are characterized by large size. Mature cows of the breed seldom weigh less than 1,200 pounds and not infrequently reach a weight of 1,400 to 1,500 pounds. The bulls, when mature, often exceed 2,000 pounds in weight.

A typical Holstein cow is shown in Fig. 6, and a bull of the same breed is shown in Fig. 7. The characteristic wedge shape is usually strikingly developed in these cattle. In general, the form is inclined to be spare, although in many individuals there is considerable muscular development, even approaching what may be termed beefiness. The bones of the Holstein are long and, in general, straight. The animals have long, straight faces, long backs, long ribs, and the legs, in some cases, are rather long. The back and legs are straight, although there is often a decided tendency for the back to droop from a point over the hip bones to the root of the tail.

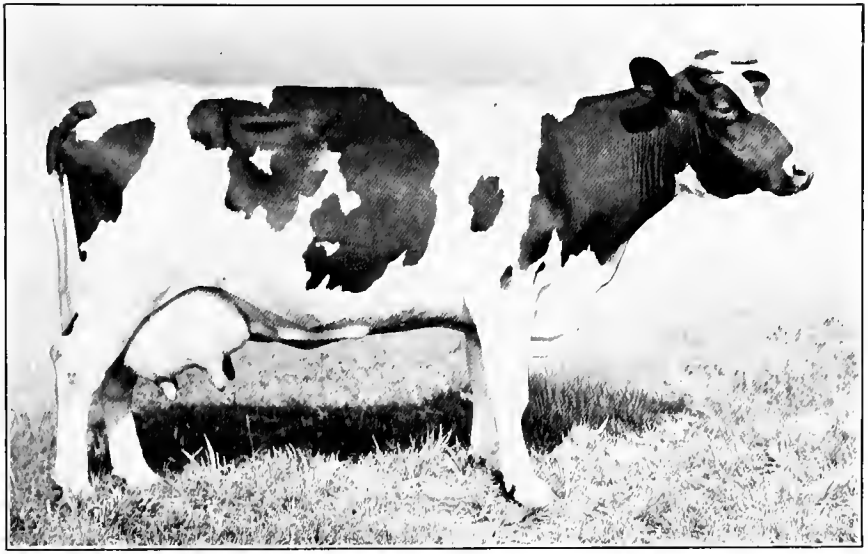


FIG. 6

FIG. 7

Some of the best authorities on the Holstein-Friesian cattle describe three characteristic types known, respectively, as the *milk*, the *beef*, and the *milk-and-beef types*. In the **milk type,** the form is excessively spare and the bones exceedingly prominent, so much so as to indicate lack of vigor in some cases. In the **beef type** there is much muscular development, although, even in extreme cases, this does not approach the ideal beef type as seen in the distinctly beef breeds. The **milk-and-beef type** occupies an intermediate place between the other two, and is the type that a large number of Holstein breeders consider the most desirable.

19. A prominent character of Holstein cattle is their color, which is distinctly black and white, the two colors being entirely separate from each other. The proportion of the two colors is variable, running from almost all white to almost all black; during recent years the proportions most desired by the breeders have been rather more white than black, with the two colors in rather large patches. Although animals marked in this way are considered to be more desirable, little discrimination is made against those showing other proportions of color. Certain colors or markings run more or less in family lines, but definite proportions of color or peculiar markings are not strongly inherited, and light-colored animals are frequently produced from dark-colored parents, and vice versa. The black-and-white color is transmitted very strongly when Holstein cattle are crossed with other breeds. One peculiarity of coloration that sometimes occurs in this breed is of interest to breeders. Occasionally, a red-and-white calf will be born from pure-bred black-and-white parents. In Holland, although black-and-white animals make up by far the larger part of the total stock of the country, there are herds in which red-and-white animals are kept. These red-and-white animals are not discriminated against in selection if they are females, but, almost universally, black-and-white males are chosen for breeding purposes. In America, none but black-and-white animals are recognized by the breeders or by the herd-book

association. Nevertheless, after many generations of such breeding in this country, occasionally red-and-white calves are produced. The percentage, however, of such births is exceedingly small, probably not much more than one in a thousand.

20. Holsteins are generally considered to possess strong constitutions, important factors of which are strong appetite and large digestive capacity. Holstein cattle are not better fitted to withstand unfavorable conditions of climate nor are they more resistant to diseases than cattle of other breeds. However, the calves are born large and strong and grow rapidly when young, in which respect this breed has a distinct advantage over some others.

In temperament, Holsteins are mild, quiet, and indisposed to much active movement. This is particularly the case with large old cows that are heavy milk producers. The bulls are tractable and easily managed.

21. Holstein cows excel those of all other breeds in milk production. The percentage of butter fat in the milk, however, is small, in occasional instances so small as to interfere seriously with the sale of the milk as such. In addition, the butter fat in Holstein milk is soft and of rather light color, but with modern methods of butter manufacture these disadvantages are largely overcome, so that, taking into consideration the large quantity of milk produced, Holsteins are often as satisfactory as any cattle from the standpoint of butter production.

22. Registry of Holstein-Friesian Cattle.—The herd book of the Holstein-Friesian breed in North America is maintained by the Holstein-Friesian Breeders Association. This organization had a peculiar origin. The first importer of Holstein cattle brought his animals directly from Holland and for a long time either he, or those to whom he had sold cattle, owned nearly all the animals of this breed in North America. The importer organized an association which he completely dominated and to which he gave the name of the

Holstein Breeders Association, calling the cattle Holstein cattle. The reason for this latter action was never satisfactorily explained. After a time rival breeders claimed that the name Holstein had been chosen in order to allow the importation of cattle from countries other than North Holland and West Friesland, and these breeders formed a rival association, which was known as the Dutch-Friesian. Both associations established herd books and imported cattle from the same localities and often from the same farms in Holland. The controversy was active throughout the whole time that importations were being made in large numbers. In 1885, however, the two associations recognized the damage they were doing each other and the breed, and compromised their differences by combining under the present name of the Holstein-Friesian Breeders Association, which is now the only recognized organization for the breed in North America. Eligibility to record in the herd book is based on purity of breeding, as is the case in all breeds.

Breeders of Holsteins were the first in North America to recognize the importance of milk and butter-fat production as a factor in the selection of animals for the improvement of the breed, and as early as 1880 established a system of advanced registration. This, so far as is known, was the first attempt to recognize anything more than the pedigree in the registration of pure-bred animals. The first system of advanced registration was crude, but improvements were made from time to time, and in 1894 it was finally put on a secure basis by asking the state agricultural colleges and experiment stations to assume the responsibility of a disinterested supervision of tests. The success of this system has been great, and now only animals with advanced registry records are considered by all of the more careful breeders to be worthy for breeding purposes. The system of advanced registration has not only resulted in the development of a large number of high-class individuals, but its influence is beginning to be felt on the breed as a whole, and the average productive capacity has been considerably increased.

23. As a basis for advanced registration, Holstein breeders recognize two kinds of records: those made for a short period of time, 7 to 30 days, with constant supervision, and those made for a period of 1 year, with supervision for 2 days in each month. The first is known as an *official record;* the second as a *semiofficial record.* In order to be admitted to advanced registration under an official record, the cow must produce in 7 consecutive days 7.2 pounds of butter fat if she calves at 2 years of age or under. With advancing age, this requirement is increased .00439 pound of butter fat for each day the cow exceeds 2 years, until she is 5 years of age, at which time she is required to yield 12 pounds of butter fat in 7 consecutive days, after which age no further increase in production is required.

In order to be admitted to advanced registration on a semiofficial record, a cow calving on or before the day she is 2 years of age shall produce during that period of lactation, and within a period of not exceeding 365 consecutive days, not less than 250.5 pounds of butter fat; and for every day that she exceeds 2 years of age at last calving, the requirement in butter fat shall be increased $\frac{1}{10}$ pound. This increased requirement of $\frac{1}{10}$ pound of butter fat daily for each day's increase of age shall continue until the requirement reaches 360 pounds at the age of 5 years, after which no further increase shall be made.

A bull, to be eligible to advanced registry, must be the sire of four or more daughters which have been admitted to this registry on officially authenticated butter fat-records.

AYRSHIRE CATTLE

24. Origin of Ayrshire Cattle.—As the name implies, the **Ayrshire breed** of cattle originated in the county of Ayr in Southwestern Scotland. The people in this part of Great Britain were among the first to develop a dairy industry, and the cattle were the result of breeding and selection from the rather composite native stock of the country. Ayrshire cattle, as a distinct breed, were practically unknown at the

beginning of the 19th century, although there were many herds of cattle in Ayr that were notable for milk production. There are traditions of early importations of cattle to Ayr from the Channel Islands, and from the Shorthorn districts of Durham and Yorkshire. Besides, there is an exceedingly vague tradition that cattle from ships of the Spanish Armada wrecked on the southwestern coast of Scotland escaped to the land and had an influence on the native stock. However, these traditions have never been authenticated.

25. Importation and Development of Ayrshires in North America.—The Ayrshire breed was the first of the distinctly dairy breeds to be introduced into North America. Many animals were brought over in the first half of the 19th century by Scotch settlers in Canada and the northern part of the United States. Importations were also made about or shortly after 1850. The development of the breed has gone on more or less simultaneously on both sides of the Atlantic, and has given rise to two types of cattle, known as the American type and the Scotch, or Canadian, type.

Ayrshires of the so-called American type are largely descended from animals imported into the United States before 1880. These animals multiplied rapidly in New England and in the northern and southwestern part of the state of New York. They fell into the hands of dairy farmers who gave considerable attention to milk production and little to other considerations, and from these animals the American type was developed. The animals of this type usually possess more open and coarser forms, and are usually of a darker color than those of the Scotch, or Canadian, type. They are still found on many farms in the state of New York and in New England, but are seldom seen in the show ring.

The Scotch breeders, and following them the Canadian breeders, gave more attention to refinement of form and so-called style than the American breeders, with the result that the cattle of the Scotch, or Canadian, type are usually somewhat smaller, with rounder and smoother forms, and a more

FIG. 8

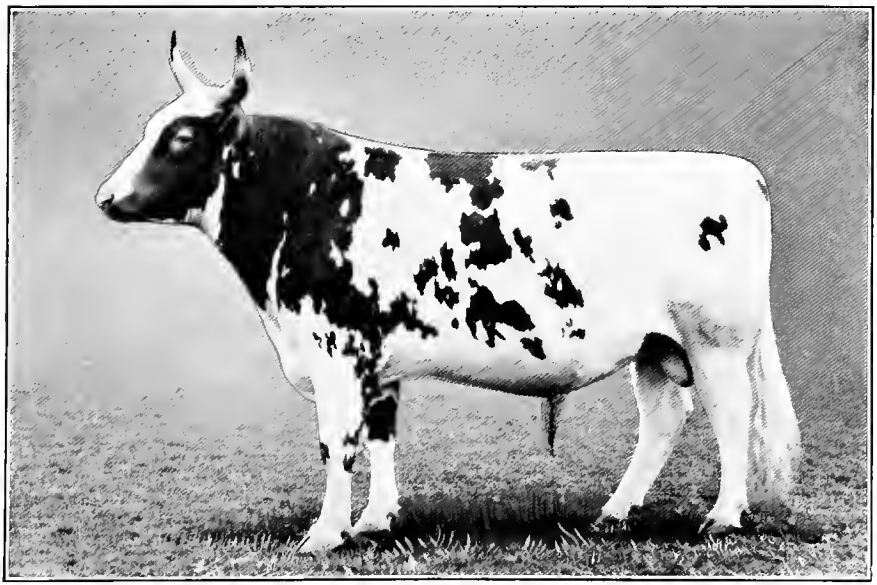


FIG 9

upright and sprightly carriage than are those of the American type. The Scotch breeders also gave particular attention to the shape and symmetry of the udder, selecting those animals in which the udder was developed far forwards and backwards and was broad and level on the bottom. They cared little whether the teats were short or long, provided they were placed evenly on the lines of a square and far apart. Since 1880, many American breeders have imported animals of the Scotch type from both Canada and Great Britain.

For some years after the introduction of Holsteins, Jerseys, and Guernseys, the Ayrshires did not increase rapidly, and in some localities even decreased in number. This was due, in a measure, to the fact that Ayrshire breeders were among the last to take up and develop the milk and butter-fat productivity of individual animals. At the present time the Ayrshire is beginning to gain ground in this respect, and Ayrshire cows are making good records in milk and butter-fat production.

26. Description of Ayrshire Cattle.—The Ayrshire cattle are of medium size. The American standard calls for a weight of about 1,000 pounds in the case of mature cows, and of 1,500 pounds for mature bulls. The Scotch standard calls for a weight of about 1,050 pounds for a mature cow.

A typical cow of the Ayrshire breed is shown in Fig. 8, and a bull of the same breed is shown in Fig. 9. The characteristic wedge shape of the dairy type is clearly defined in the Ayrshires. Their lines are straight and their bones fine and well knit together, which gives them a smooth appearance even when they do not carry much flesh. They are particularly round in the barrel, and the hindquarters are long, strong, and square. The cows commonly have large, symmetrical udders, with rather small teats placed wide apart and on the lines of a square.

27. In color, Ayrshires are the most variable of any of the dairy breeds, running from almost pure white to all admixtures, except roan, of white with yellow-red, red, dark red, brown, and even black. The most common color at the

present time is dark red and white, with a large preponderance of white in most cases.

28. Ayrshire cattle are strong and vigorous, and are perhaps better able to withstand vicissitudes of climate than any of the other distinctly dairy breeds. Their activity makes them good foragers, and they will range over a wider area and thus do better on sparse pastures than the heavier and more inactive breeds.

The Ayrshires are active and somewhat inclined to be nervous and irritable. The latter is an objectionable feature in the animals when they are carelessly treated, but it largely disappears when they are carefully and properly managed.

29. Although definite statistics are lacking, it is commonly believed that Ayrshires are particularly economical users of feed, and that, in proportion to the feed consumed, their milk production is relatively high. Ayrshires give a large flow of milk, ranking next to Holsteins in this respect, although the milk is not particularly rich in butter fat, seldom exceeding 4 per cent.

30. Registry of Ayrshire Cattle.—In the United States, the interests of Ayrshire cattle are fostered by the Ayrshire Breeders Association, which was organized in 1875. In Canada, the Dominion Ayrshire Breeders Association records the pedigrees of Ayrshires. The latter association was established in 1889.

A system of advanced registration was adopted in 1902 by the Ayrshire Breeders Association, but progress in recording animals in the advanced registry has been slow. The requirements for advanced registration are less exacting than for the other breeds, and are as follows for females:

If a female's record begins the day she is 2 years old or before that time, she must give not less than 6,000 pounds of milk and 214.3 pounds of butter fat in 365 consecutive days, and for each day she is over 2 years old at the time of the beginning of her test there shall be added 1.37 pounds of milk to the 6,000 pounds, and .06 pound of butter fat to the

214.3 pounds. A 3-year-old cow must give 6,500 pounds of milk and 236 pounds of butter fat, and for each day she is over 3 years old at the time of beginning the test, there shall be added 2.74 pounds of milk to the 6,500 pounds, and .12 pound of butter fat to the 236 pounds. The same additions shall be made for 4-year-old and mature cows—those 5 years old and over. When a cow is 4 years old she must give 7,500 pounds of milk and 279 pounds of butter fat. A mature cow—that is, one 5 years old or over—must give 8,500 pounds of milk and 322 pounds of butter fat.

No bull shall be eligible to advanced registry unless he shall have been previously recorded in the Ayrshire record.

A bull, to be eligible to advanced registry, must be a typical Ayrshire bull in general appearance, must score 80 points of the official score card, and must have two daughters in the registry from different dams.

A bull may be admitted to advanced registry without physical qualifications, and without being scored, provided he has four daughters in the advanced registry by different dams.

MISCELLANEOUS DAIRY BREEDS

DUTCH BELTED CATTLE

31. Origin of Dutch Belted Cattle.—As the name implies, the **Dutch Belted breed** of cattle originated, like the Holstein-Friesians, in Holland; but, although the two breeds are of common origin, they are not closely connected. On many of the larger estates in Holland there is kept a strain of cattle known as the Lakenfelders, the animals of which possess the general characteristics of Dutch Belted cattle. It is believed that these Lakenfelders were the parent stock of the Dutch Belted breed.

32. Dutch Belted Cattle in North America.—Dutch Belted cattle were introduced into the United States by early Dutch settlers, supposedly direct from Holland. The breed

FIG. 10

FIG. 11

has not increased as rapidly as most of the other dairy breeds, although animals of this breed are found scattered over the dairy districts of the United States and Canada. Perhaps they are most numerous in the southeastern part of New York, the northeastern part of Pennsylvania, the northern part of New Jersey, and in the New England States.

33. Description of Dutch Belted Cattle.—Dutch Belted cattle are of medium size, being in this respect comparable to the Ayrshires. The cows average about 1,000 pounds when full grown, and the mature bulls about 1,500 pounds.

Animals of this breed have a distinct dairy form. Four typical females of the breed are illustrated in Fig. 10, and a representative bull is shown in Fig. 11.

In color, the Dutch Belted cattle are black and white; the black is confined to the forequarters and hindquarters and the white extends in a broad belt about the middle. Much attention is given by the breeders to the particular markings of the animals. In a perfectly marked specimen, the white belt should extend from the shoulders back to the hips in a regular band around the whole body. In the case of the cows, the band, or belt, includes the forward half of the udder; in the case of the bulls, the belt is similar, except that the sheath of the penis is usually black. A very narrow belt or a belt running onto the forequarters or the hindquarters is looked on with disfavor, as is any irregularity of the belt, such as a black spot in the white or broken patches of white in the black areas.

In milk production, the Dutch Belted cattle possess considerable merit, and there are many animals of the breed that are listed high in this respect.

34. Registry of Dutch Belted Cattle.—In 1886, an association for recording the pedigrees of Dutch Belted cattle was formed, known as the Dutch Belted Cattle Association of America. No system of advanced registration has thus far been adopted.

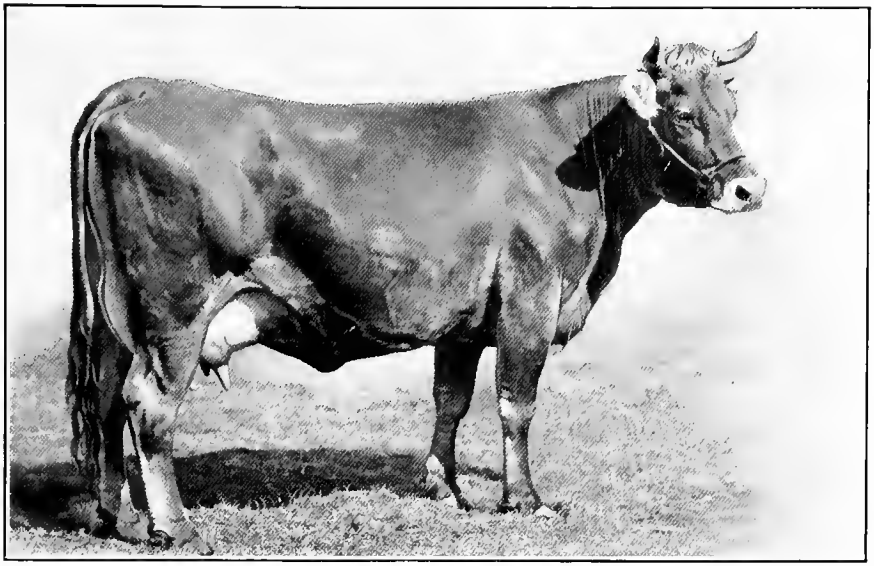


FIG. 12

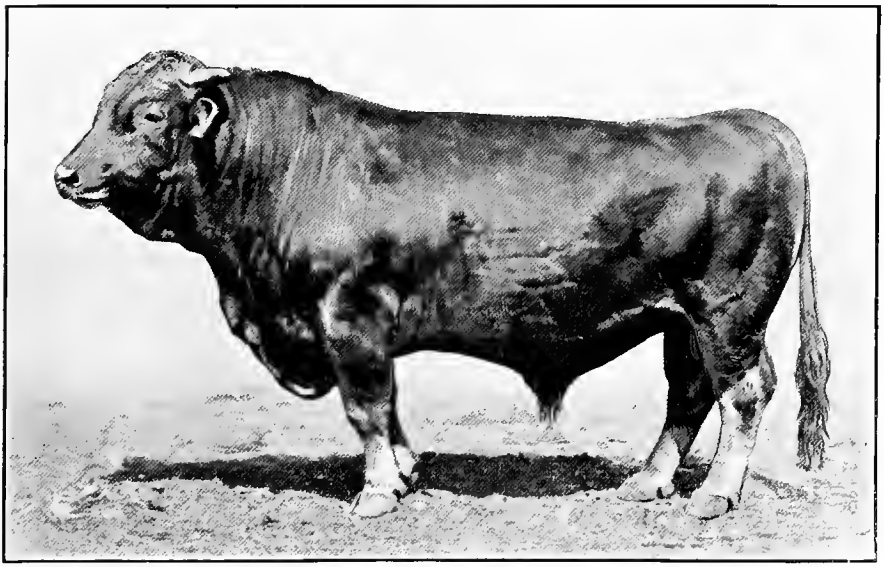


FIG. 13

BROWN SWISS CATTLE

35. Origin and Importation of Brown Swiss Cattle.—The **Brown Swiss breed** of cattle originated in the Canton of Schwyz in the eastern part of Switzerland, where they are the common cattle found in mountain pastures. They have been developed by the Swiss farmers by the selection of native stock and are noted as being good producers of milk and butter fat. Brown Swiss cattle were first brought to North America about 1870, but the number was small and although there have been numerous small importations since, the breed has not increased rapidly in numbers.

36. Description of Brown Swiss Cattle.—Brown Swiss cattle are of large size and rather heavy form. A cow of this breed is shown in Fig. 12, and a bull in Fig. 13. The bones of the head and legs are large and strong, giving the animals a sturdy appearance. Many specimens have considerable muscular development, enough to be described as beefy, although they do not approach the pronounced beef type as seen in beef breeds.

In color, the Brown Swiss are of a uniform dark grayish-brown or mouse color, running toward gray in the flanks and on the belly, and with a light ring about the muzzle. There is little variation in the color. Occasionally, an animal will shade a little darker toward black and occasionally one a little lighter toward light gray.

In temperament, the Brown Swiss are quiet and docile. They are hardy and vigorous and, as a rule, easy to keep in good condition.

As milk producers, they vary considerably. Few individuals have made notable records.

37. Registry of Brown Swiss Cattle.—The interests of the Brown Swiss breed are looked after in North America by the Brown Swiss Breeders Association, which maintains a herd book for the registration of pure-bred animals. No system of advanced registration has been established for the breed.

SIMMENTHAL CATTLE

38. The **Simmenthal breed** of dairy cattle is closely related to the Brown Swiss breed. The animals of the Simmenthal breed are from the valley of the Simme in Switzerland, and are found in largest numbers in the vicinity of Berne, in that country. They are similar to the Brown Swiss in all respects save color. In color, they are a light fawn mixed with white. Only a few have been imported into America.

FRENCH CANADIAN CATTLE

39. Origin and Development of French Canadian Cattle. The early French settlers in Canada brought with them cattle from France, which formed the foundation stock for what is now known as the **French Canadian breed** of cattle. These cattle have been bred with but little mixture of outside blood until recently. Within the last 100 years dairying has developed to a considerable extent in the so-called French part of Canada, and the cattle have been somewhat improved by selection. It is said that recently there has been some mixing of the blood of Jersey with that of French Canadian cattle. Especial attention has lately been called to the French Canadian cattle, and several herds have been imported into the United States, notably into the state of New York. There is no organization of the breeders of these cattle in the United States. In Canada, the herd book of the breed is maintained by the French Canadian Cattle Breeders Association.

40. Description of French Canadian Cattle.—French Canadian cattle are small, of a strictly dairy type, and somewhat resemble the Jersey in form. In color, they vary from a dark reddish brown to black, and almost never have any admixture of white. They are prized by their owners on account of their activity and vigor and their ability to thrive under adverse conditions as to feed and climate. They have not, as yet, become firmly established as a breed in any part of the United States.

DEVON CATTLE

41. Origin and Development of Devon Cattle.—The **Devon breed** of cattle originated in England in the County of Devon, which has long been noted for its dairy products. Devon cattle were early introduced into the United States and obtained a foothold in many of the eastern states in localities where the surface is rough and where the ox was largely used for labor. They were esteemed for their capacity to produce milk and for the quality of their flesh. In localities where they have been introduced they have always maintained a secure foothold, although in somewhat small numbers. They do not come in competition with the leading dairy breeds in districts where dairying is most highly developed. The official organization for the promotion of the breed in this country is known as the American Devon Cattle Club.

42. Description of Devon Cattle.—Devon cattle are of medium size, with light, fine bones and smooth, rotund forms. By some they are termed a dual-purpose breed; that is, they are regarded as valuable for both beef and milk production. They are active and sprightly in carriage, and are considered to be among the most intelligent of cattle.

In Fig. 14 is shown a representative Devon bull with the rotund form well defined.

In sections where the ox is still used as a beast of burden, the Devons are highly prized for this purpose. Devon oxen are strong and capable of drawing heavy loads. In color, the Devons are of a uniform dark mahogany red, with light muzzles. An occasional small white spot is seen on the lower part of the body, or abdomen, and on the udders of the cows, and in front of the scrotum of the bulls.

The cattle of South Devon are rather larger, rougher boned, and lighter colored than those of North Devon. The best dairy producers are also found among the former. The North Devon cattle are smoother of form, are a little more inclined to beef, and have darker and often curly hair.

FIG. 14

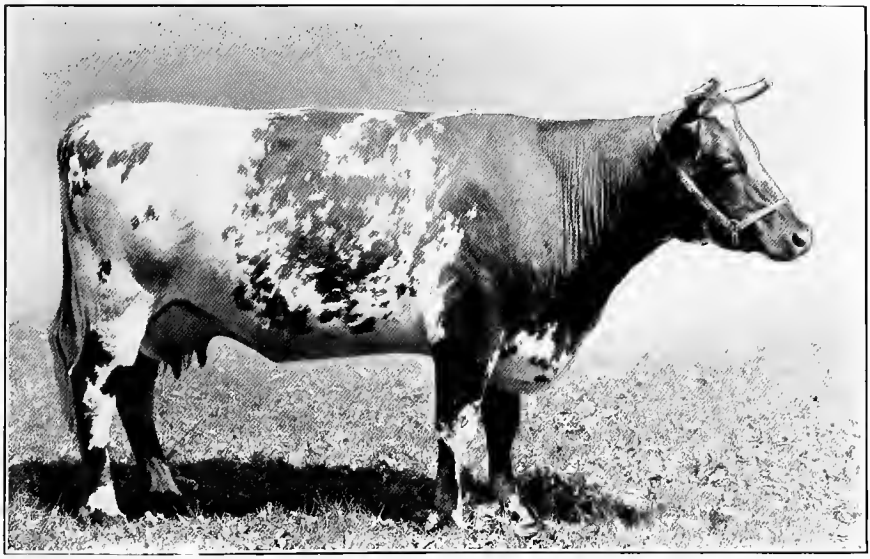


FIG. 15

242—16

SHORTHORN CATTLE

43. A description of dairy breeds of cattle would not be complete without some mention of the **Shorthorn breed**, for although the Shorthorn ranks among the best of the highly developed beef breeds, many of the progenitors of the breed were famous for dairy production, and in some parts of England and in some strains of blood the dairy qualities have been maintained to a considerable degree. The Shorthorns introduced into the eastern part of the United States were largely of this type, and a few herds have been maintained that are satisfactory milk producers, although as a whole the dairy qualities of the Shorthorns have received little attention and have almost entirely disappeared. Recently some effort has been made to develop the dairy production from the few dairy herds of this breed that remain. Some notable records have been made by individual animals, these records running up to 18,000 pounds of milk in a year and over 700 pounds of butter. The registration of Shorthorns in the United States is conducted entirely by the American Shorthorn Breeders Association. In Canada, a herd book of the breed is maintained that is known as the Dominion Herd Book. In Fig. 15 is shown a typical cow of the dairy strain of Shorthorn; this cow is Lula, owned by the Agricultural College of the University of Missouri. She has the record of having produced 12,341 pounds of milk containing 606 pounds of butter fat in 1 year. Although she does not possess the typical wedge shape of the dairy type, there is a fineness about the head and neck and a thinness of thighs usually found in dairy animals.

RED POLLED CATTLE

44. The **Red Polled breed** of cattle originated in the counties of Norfolk and Suffolk, in the eastern part of England, where they have been developed on the marshy pastures for both milk and beef production. They have been widely advertised as a dual-purpose breed and there is no doubt but

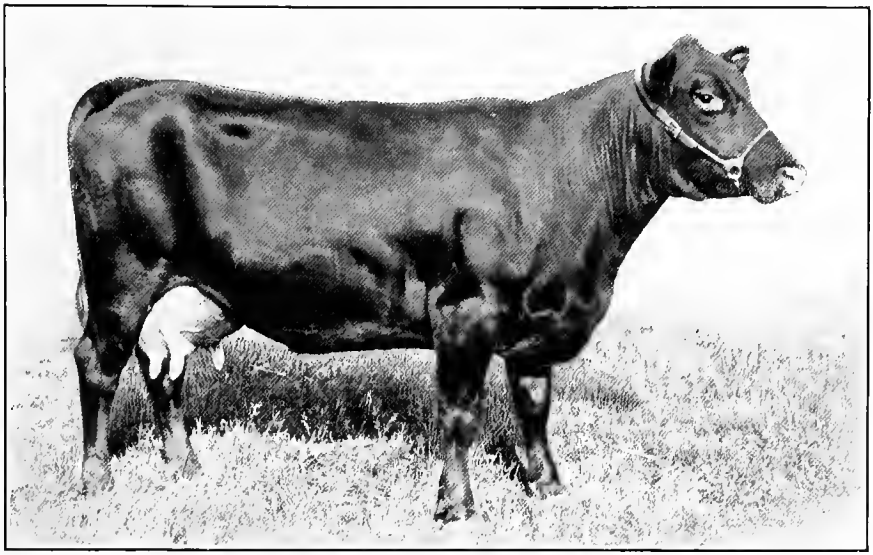


FIG. 16

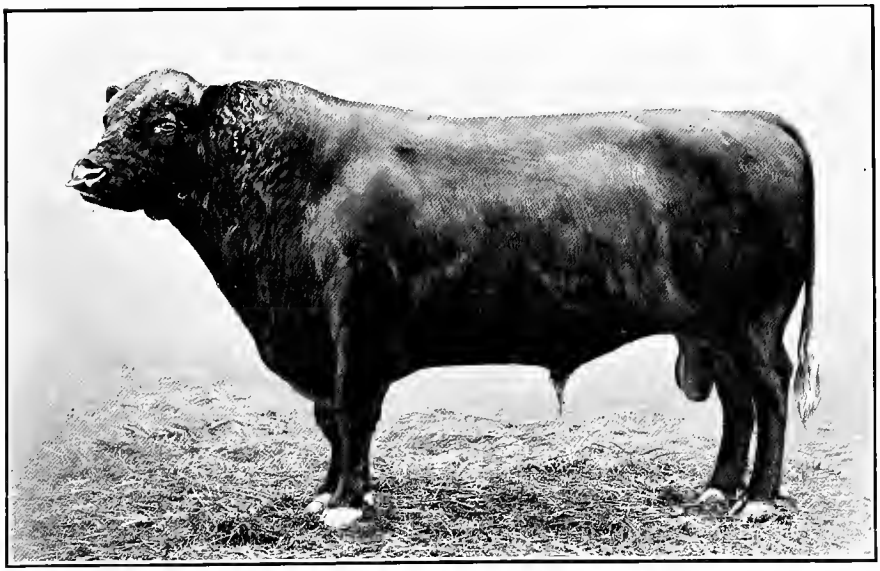


FIG. 17

that the Red Polled cattle have considerable merit both for the production of milk and of beef, but they can scarcely compete with the highly-developed dairy breeds on the one hand, or the highly-developed beef breeds on the other.

Fig. 16 shows a cow and Fig. 17 a bull of the Red Polled breed. The animals of this breed are of medium to large size, a uniform mahogany red in color, with light muzzles, and are polled, or hornless.

The Red Polled cattle are mild and quiet in disposition, and in form not unlike the Shorthorn, especially in the specimens that tend most strongly toward the beef form. It is doubtful whether, at the present time, they are more than holding their own in point of numbers. The interests of the breed in this country are looked after by the Red Polled Cattle Club of America.

DAIRY-CATTLE MANAGEMENT

(PART 1)

SELECTION OF DAIRY CATTLE

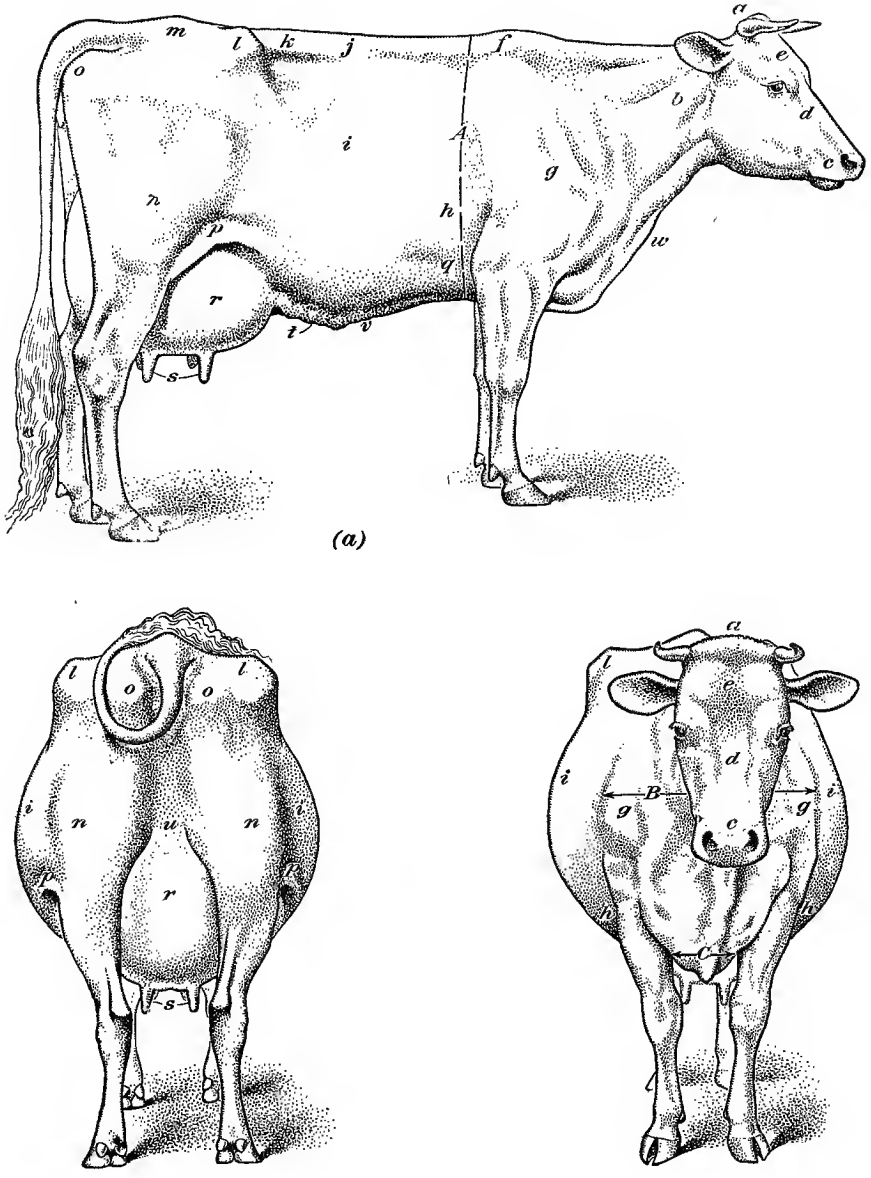
SELECTION OF DAIRY COWS

1. Records of Production.—Undoubtedly the most satisfactory guide in the selection of a dairy cow is a record of her production, that is, actual figures showing the quantity of milk she has produced in a given time and the average butter-fat content of this milk. Progressive dairymen realize the advantage of keeping such records, not only for the guidance of prospective buyers but also as a means of determining which of the cows are profitable and which are unprofitable. With records of production available, even an inexperienced man can make a satisfactory selection of cows; and the most expert judges of dairy cattle frequently make a poor selection if they do not have information showing what the cow has produced in the past.

Obviously, it is to the interest of the dairyman who is buying cows to purchase, as far as possible, from herds of which records of production are kept. When, for any reason, this is impracticable, it is necessary to depend on other indications of milk-producing qualities.

2. Use of the Score Card.—The score card on page 4, which gives a list of the important points that should be taken into consideration in judging an animal, will materially assist the beginner in selecting his animals. The figure given

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ENTERED AT STATIONERS' HALL, LONDON



(a)

(b)

(c)

FIG. 1

opposite each item in the first column to the right indicates the perfect score for that particular item and the last column on the right contains blank spaces in which the person doing the judging may indicate the degree to which, in his opinion, the animal approaches perfection in each detail enumerated.

In Fig. 1 (*a*), (*b*), and (*c*) are shown, respectively, a profile view, a rear view, and a front view of an animal, on which the various parts, as usually given on a score card, are indicated by letters, and certain dimensions that will be explained presently are also given.

The names and locations of the parts are as follows:

a, Poll
b, Neck
c, Muzzle
d, Face
e, Forehead
f, Withers
g, Shoulders
h, Chest
i, Barrel
j, Back, or chine
k, Loin
l, Hips
m, Rump
n, Thigh
o, Pin bones, or thurls
p, Flank
q, Fore flank
r, Udder
s, Teats
t, Milk veins
u, Escutcheon
v, Navel
w, Dewlap

It should be kept in mind that the chief use of a score card is to enumerate the essential points and indicate their relative importance. When these details are sufficiently well mastered to be carried in the mind, the score card may be dispensed with to a large extent.

The score card shown is necessarily somewhat general in nature, since it is designed to be used for cows of all breeds and grades. Most of the associations representing the various breeds of dairy cattle have formulated a special card adapted to the particular breed represented by the association.

3. Chest Capacity.—The secretion of milk makes a large demand on the organs of respiration, for the chemical changes involved in the formation of milk from constituents of the blood require a large quantity of oxygen. Hence it is necessary that a good dairy cow should have a large, roomy chest, providing ample space for the fullest possible development

SCORE CARD FOR DAIRY COW

General Appearance	Perfect Score	Judge's Score
Form: wedge-shaped as viewed from the front, side, and top	5	
Form: spare, as indicated by prominent joints and clean bone and lack of muscular development along ribs and loins	8	
Quality: hair fine, soft; skin pliable, loose, medium thickness; secretion yellow, abundant	8	
Constitution: vigorous, as indicated by alert expression, evidently active vital functions, and general healthy appearance	6	
Head and Neck		
Muzzle: clean cut; mouth large; nostrils large Eyes: large, bright Face: lean, long; quiet expression Forehead: broad, slightly dished Ears: medium size; fine texture Neck: fine, medium length; throat clean; light dewlap	6	
Forequarters and Hindquarters		
Withers: lean, thin; shoulders: angular, not fleshy	3	
Hips: far apart; not lower than spine Rump: long, wide, comparatively level Thurls: high, wide apart	5	
Thighs: thin, long	2	
Legs: straight, short; shank fine	1	
Body		
Chest: deep; with large girth and broad on floor of chest; well-sprung ribs	10	
Abdomen: large, deep; indicative of capacity; well supported	4	
Back: lean, straight; chine open	2	
Tail: long, slim, with fine switch	2	
Loin: broad	2	
Udder: large, long; attached high and full behind; extending far in front and full; quarters even	20	
Udder: capacious, flexible, with loose, pliable skin covered with short, fine hair	10	
Teats: convenient size, evenly placed	2	
Milk veins: large, tortuous, long, branching, with large milk wells	4	
Total	100	

of the lungs. The visible air passages, which include the nostrils and windpipe, should be large, clean, and free from obstructions of fatty or other tissues. Small passages, or large passages constricted by accumulations of fat, must necessarily impede the free inspiration and expiration of air.

The capacity of the chest is determined, first, by depth of the body from the top of the backbone to the floor of the chest, as shown in Fig. 1 (*a*) by the dotted line *A*; second, by the spring, or curvature, of the ribs, which is indicated by the transverse diameter of the chest at its widest point, as shown in (*c*) by the line *B*; and third, by the width on the floor of the chest, as shown in (*c*) by the line *C*.

It should be noted that some dairy cows are wedge-shaped, as viewed from the side, on account of a deficiency in depth of chest. The wedge shape is a desirable feature in dairy cows, but when, as in the case mentioned, it is secured at the expense of depth of chest it is of little value. The wedge shape should come from large development of the hindquarters rather than from dwarfing of the forequarters. Experienced dairymen recognize this and look first for a deep chest then for animals having sufficient development of the hindquarters to give them a wedge shape. As a general rule, it is considered that the distance from the top of the backbone, immediately behind the shoulders, to the floor of the chest, immediately back of the fore legs, should not be less than one-half of the total height of the animal.

A dairy cow may present a good depth of chest but at the same time be deficient in width of chest. If the ribs are not well sprung and come together at an acute angle at the lower ends, the capacity of the chest will be more or less constricted, which condition entails a reduced lung capacity. In somewhat the same way that a shallow chest accentuates the wedge shape, a narrow chest may give to its possessor a somewhat trim and attractive form. The dairyman should endeavor to recognize animals in which a pronounced wedge shape is due to flat ribs and consequently a narrow chest.

The chest capacity of a dairy cow is sometimes estimated by the conformation of what is known as the *heart girth*,

which is the girth just back of the fore legs, as illustrated by the line *A* in Fig. 1 (*a*). If the space between the elbow joint and the wall of the chest is excessive the animal is said to be deficient in the fore flank. It should be noted, however, that the conformation of the individual varies considerably with respect to the closeness with which the shoulder blade and fore arm are attached to the body. Apparent lack of heart girth may be due to a loosely attached shoulder and fore arm rather than to narrowness of the chest itself. In other cases an extremely round-ribbed animal may be apparently deficient in the fore flank because of a sharp inward curvature of the lower ends of the ribs. When an animal is found to present the appearances of deficiency in the fore flank, an extremely careful examination should be made in order to determine the real conformation of the animal and the capacity of the chest. In making this examination, the hand should be passed across the floor of the chest immediately back of the fore legs and in this way the actual width at this point determined. Another method of estimating this width is by observing the space between the fore legs at the bottom of the line of the chest. This dimension is indicated by the line *C* in Fig. 1 (*c*).

4. Circulatory System.—The milk is elaborated in the udder from certain constituents of the blood as the latter circulates through the extensive system of vessels contained in the organ. Obviously, in order to secrete large quantities of milk, the cow must possess not only an abundant supply of blood but also ample facilities for the circulation of this fluid. Vigor of circulation is indicated externally by the appearance of certain blood vessels that are prominent on the dairy cow. The vessels known as the *milk veins*, so called from the fact that uninformed persons have supposed that they carry milk, are perhaps the most important structures of this kind. In Fig. 1 the milk veins are shown at *t*. They extend in a more or less irregular course from the udder forwards along the under side of the abdomen, entering it in the region of the navel through openings known as *milk*

wells. The size and elasticity of these milk veins form a basis for estimating the volume of blood circulation in the udder.

The simplest form of milk veins is that of two rather small, almost straight vessels located as already described. In their extreme development, milk veins are a network of large vessels covering almost the entire floor of the abdomen from the udder to the navel. Ordinarily, those on opposite sides are distinct, though sometimes branches extend from one to the other.

A good development of milk veins will show the principal vessels somewhat larger than the finger. The course of these vessels will be extremely tortuous and will extend to a point somewhat beyond the umbilicus. Branches from the main vessel frequently extend forwards almost to the fore arm, where they enter the abdominal wall. The milk veins on the opposite sides of the same animal are seldom symmetrical; those on one side may be simple and those on the other side much branched.

It is safe to say that most cows showing well-developed milk veins either are or have been good milk producers. It should be carefully noted, however, that many good milk-producing cows do not exhibit particularly strong development of milk veins. This is especially true in the case of cows under 4 or 5 years of age, for the veins are small in young animals and increase in size as the animals advance in age. As a rule, judges of dairy cattle place much stress on the milk veins as an index of the producing qualities of cows, and they are undoubtedly important, but, at the same time, it is possible to overestimate their importance.

Other external blood vessels that are most prominent and most useful in indicating vigor of circulation are seen on the udder, on the face, and on the fore flank. If the veins in the regions mentioned are prominent, full, and elastic, this condition may be regarded as good evidence of a vigorous circulation.

In this connection it is perhaps well to note that the degree of prominence of all the veins mentioned will depend to a

considerable extent on the quality of the animal's skin. Two cows may possess uniformly well-developed veins, but if one has a fine, thin, flexible skin and the other a coarse, thick skin, the veins will appear much more prominent in the former animal. For this reason it is necessary, in examining a cow for the quality under discussion, to take into consideration the condition of the skin.

In addition to the veins already described, the *capillary circulation* is also of importance in estimating the vigor of the general circulation. If the mucous membranes in the eyes, nostrils, vulva, etc. are of a bright pink color, vigorous capillary circulation is indicated. On the other hand, a dull, pale appearance of these membranes is good evidence of a defective capillary circulation.

5. Digestive System.—The dairy cow consumes a large quantity of bulky feed, consequently the digestive organs must be large and capacious to take care of the feed. The size of the abdomen indicates the capacity of the paunch and is an important element in determining the wedge shape of the typical dairy cow. It should be stated, however, that a very pendent abdomen is not necessarily a capacious one. The contents of the abdomen are held in place by muscular walls, and if these walls are strong and tense the abdominal viscera are held close to the backbone and there is no marked hollow in front of the hips and below the loin. In such cases the digestive organs may be of comparatively large capacity and yet not more than ordinarily prominent. It is desirable that the walls of the abdomen be strong and the contents well held up, not only for convenience in moving about but also as an indication of constitution and vigor.

As explained elsewhere, the process of assimilation is just as important as that of digestion. A profitable dairy cow must be able not only to digest large quantities of feed, but also to assimilate this material into the blood where it may be used for milk production. Just as animals vary in their digestive capacity, so also do they vary in their capacity to assimilate feed. Strong assimilative powers are indicated

externally by the appearance of an oily secretion on the skin, particularly inside of the ears, along the backbone, and at the tip of the tail. As a result of this secretion, there will be a fine, lustrous appearance of the hair, a soft, pliable skin, and an abundance of soft, oily dandruff. The presence of all the qualities is considered a strong indication of high assimilative powers, but here again it is necessary to take into consideration the fact that unfavorable external conditions may greatly alter the appearance of the qualities mentioned. Exposure to sun, storm, and wind has a tendency to remove the secretions as fast as they are formed and in the same degree the hair is likely to appear harsh and the skin stiff. On the other hand, grooming, shampooing, and blanketing tend to accentuate the secretions. From this it is evident that something should be known about the surroundings of the animal and the care she has received before reaching a conclusion as to her assimilative powers as indicated by the qualities mentioned.

6. Temperament.—The desirable dairy cow should have not only the proper conformation for milk secretion but also a disposition, or temperament, favorable to this function. It is a recognized fact that of two animals alike in respect to other qualities and under identical conditions as to feed, care, etc., one may yield good returns and the other indifferent or poor returns, as a result of difference in temperament. But just what the external indications of a desirable temperament are has never been satisfactorily defined, and for that reason it is not possible to specify them here. It has been claimed that cows with very highly developed nervous systems are more likely to be large producers than those that are sluggish and phlegmatic, and that the latter are the most inclined to lay on flesh. In support of this claim it may be said that many high producers have a very highly developed and sensitive nervous organization, and consequently are easily disturbed or thrown out of balance. This characteristic is said to be common in certain dairy breeds. It is doubtless true, however, that many cows have been large

producers simply because they were not easily disturbed or thrown out of balance by unfavorable external conditions. That there can be no great difference in the functions of the animal as between the secretion of fat in milk and laying up fat in the tissues of the body is indicated by the fact that most cows that are large producers of milk will, when dry, lay on flesh, that is, become fat, if given an opportunity to do so.

7. Udder Development.—By far the best indication of the ability of a cow to give milk is furnished by the organ of milk secretion, the udder. In selecting dairy cows, the size, shape, and structure of the udder is a point that should be given careful consideration.

In forming an idea of the size of the udder, the conformation of the thighs and pelvis must be taken into account. For example, in the case of an animal having thin thighs set wide apart, a large udder may be somewhat concealed by these structures, particularly if the organ is held close up to the abdomen by the fibrous and muscular tissues that support it. In another case, a small udder may be forced into such prominence as to appear large if the thighs are thick and fleshy, joined together low down under the pelvis, and the supporting tissues of the organ are relaxed.

Whatever the conformation of the animal, the udder should be large and well developed. It should be full on the sides, between the thighs, extend well up toward the vulva, and outwards at least as far as the outer angle of the thighs. The appearance of a desirable udder structure in those parts is shown in Fig. 1 (*b*). The fore part of the udder should be full, well rounded, carried close to the abdomen, and extend well forwards on the belly. The udder should be smooth and symmetrical in shape and free from irregularities or marked constrictions between the quarters. It may be said, however, that these latter points are largely matters of symmetry and appearance. There is no evidence to prove that an udder of irregular shape does not secrete as much as an udder of regular shape if other factors are equal. A very pendulous, or bottle-

shaped, udder, particularly if it is a large one, is not easy or convenient to carry, and for this reason is undesirable and furthermore is somewhat unsightly.

The capacity of the udder depends on its structure as well as on its size and shape. Milk is secreted in numerous glandular follicles, and these should make up a considerable part of the udder structure. In some udders, however, fat deposited in the connective tissues gives the appearance of large development of this part, when in reality the organ may be deficient in glandular structure and consequently inefficient as a milk-producing organ. An udder of the character just described is referred to as fleshy, or meaty, and is believed to be more subject to disease than is a normal udder. The presence of fat in the tissues of the udder is indicated externally by a certain lack of elasticity of the organ, a condition that is determined by manipulation with the hand. Another indication is in the failure of the udder to shrink in size during the milking process. The fleshy udder will be nearly the same size and shape after milking as it was before the operation, and it is largely by this fact that the experienced dairyman judges the structure of the organ. Where it is not possible to see the udder immediately before and after a milking, a skilled person will be able to determine by careful manipulation whether or not it is objectionably fleshy. If the udder is not fleshy, it will show a considerable degree of elasticity even when full of milk. Furthermore, if the skin covering the udder is fine, soft, and loose, and if the exterior veins are prominent, there is not likely to be undue fleshiness.

In old cows, particularly those that have been large producers, the supporting tissues of the udder often become much relaxed, allowing the udder to hang considerably lower than normal. In this condition the space between the udder and the abdomen usually fills up with connective, or fatty, tissue, thus giving the cow the appearance of having an enormous udder development. If a cow of somewhat advanced age shows an extremely large udder, it is well to bear in mind that this condition may be due to relaxation of the supporting tissues.

The teats in themselves probably have no relation to the milk-secreting capacity, but as they are the structures by means of which the milk is drawn from the udder, their size and position is of importance as a matter of convenience in milking and also as affecting the general appearance of the cow. The teats should be cylindrical in form, attached to the udder in a perpendicular position, and should be from $2\frac{1}{2}$ to 4 inches in length. The position of the teats on the udder should be symmetrical, with the hind teats somewhat closer together than the front ones.

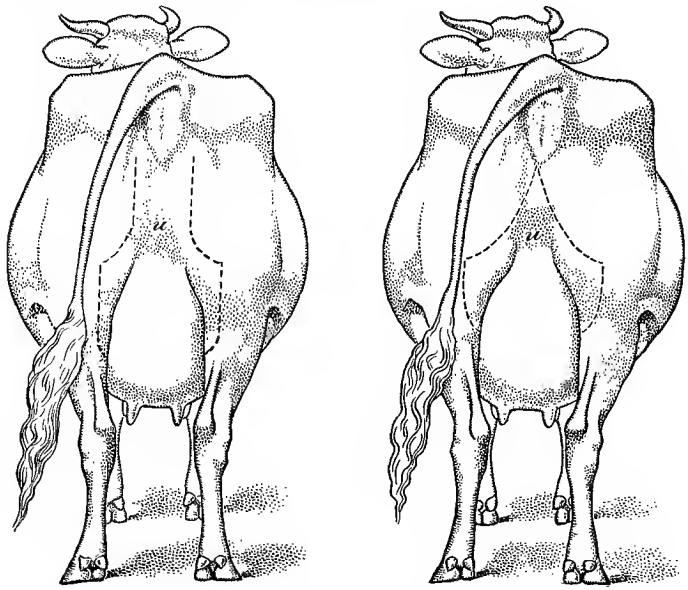


FIG. 2

8. Milk Signs.—In an effort to discover some positive external mark or indication by which the milk-producing powers of dairy cows may be judged, several peculiarities of structure that vary more or less in different individuals have been widely discussed at different times. These peculiarities, commonly referred to as **milk signs,** are practically without logical foundation as indicators of productive qualities, and are to a very large extent disregarded by well-informed dairy-

men. The fact that they have been in times past, and are yet, considered of importance by some persons, is the only warrant for mentioning them here, and the beginner should be warned against placing too much credence in them.

9. Of the so-called milk signs, the *escutcheon* has perhaps been most widely advertised and attained the most prominence. In nearly all cows and in some bulls there will be found on the inside of the thighs a greater or less area on which the hair grows upwards instead of downwards, as is the case over most of the body. This area of upgrowing hair is known as the escutcheon or milk mirror, two forms of which are illustrated at *u* in Fig. 2. It was formerly believed that cows on which the escutcheon covered a large area, extending down on the udder and up to the vulva in a broad band, were greatly superior in milk production to cows in which the development of the escutcheon was deficient. Early supporters of this belief went so far as to maintain that a cow possessing a certain definite form of escutcheon would give a certain definite quantity of milk per day for a certain definite period of time. For a time much faith was placed in this theory, but when actual records of production were kept it was soon discovered that there was no definite relation between the size and shape of the escutcheon and the quantity of milk produced. It is now generally conceded that the different types of escutcheons are to be regarded more as characteristics of certain breeds than as indicators of producing qualities.

10. The conformation of what is called the *pelvic arch* is another character that has been cited as an index of milk production. There is, however, some confusion in regard to this character, due to the fact that two pelvic arches are recognized by authorities on dairying. One is formed by the thighs and the attachment of the muscles to them and is seen from the rear. If the thighs are wide apart and the muscles joined high up, giving the appearance of roominess between the hind legs, the arch is said to be of good form. The other pelvic arch is formed by the bones of the hip and

rump. If these bones are of such form as to be prominent and make a distinct rise or arch between the hip bones and the pin bones at the root of the tail and also a more or less arched appearance from side to side immediately at the rear of the hips when viewed from behind, this arch is considered to be well developed. In so far as this conformation indicates a strong development and power to support the udder and abdomen, it is of advantage to the animal. It also indicates a roominess of the pelvic cavity, permitting the birth of well-developed calves, but it has not been demonstrated that the development of these arches is directly related to milk secretion.

11. If the hand is passed along the flank in the region between the stifle joint and the abdomen a more or less well-defined band of muscular tissue will be felt. This band is the so-called *flank vein*, or *cord*, and its prominence has been considered an indication of high milk production. It probably has no relation whatever to milk secretion further than being to some extent a support for the udder.

12. Some cows possess, in addition to the four normal teats, several *rudimentary*, *extra*, or *supernumerary*, *teats*. These extra teats are seldom more than mere elevations on the surface of the skin and usually are found behind the rear teats, sometimes on only one side but usually on both sides. Occasionally they occur between the normal teats or as branches of them. At one time dairymen were inclined to look upon these extra teats as favorable indications of high milk-producing powers, but modern dairymen are coming to regard them as valueless in this respect and as blemishes, particularly in the occasional cases in which they are so far developed that milk may be drawn through them.

13. The umbilicus, or navel, in the cow has the form of a scar on a loose fold of skin near the middle of the abdomen. In some cases the fold is loose and pendent; in others there is but little indication of a fold; likewise the scar may be distinct or barely recognizable. This character is another

of the so-called milk signs, it being supposed that a *loose, pendent umbilicus* indicates superior milk-producing qualities, but it is now generally considered that, like the escutcheon, it is largely a breed characteristic.

14. Determination of Age.—In the selection of dairy cattle, it is important that the judge be able to form a fairly accurate estimate of their age. The size of the animal, the teeth, and the horns are the characters on which expert dairymen base their estimates. In calves up to about 1 year, 1½ years, or 2 years of age, size is the chief indication. There are, of course, exceptional cases of unusually rapid growth and others in which growth has been stunted. But, as a rule, an experienced man will be able to estimate the age of calves very closely by their size. The faculty is one that is acquired by practice. No definite instructions can be formulated, but a few years' experience will usually give considerable proficiency along this line.

The appearance of the horns, when present, is a fairly satisfactory means of estimating the age of dairy animals. The growing practice of dehorning, however, makes this method useless in the majority of cases. Under normal conditions, the horn grows rapidly for 1½ years or 2 years after birth, beyond which time the growth is much slower. At about 3 years of age a distinct ring is formed at the base of the horn and each year thereafter another ring is formed. The rings are, as a rule, much more distinct on cows than on bulls, but in most cases they are sufficiently prominent to be distinguishable. The age of the animal is determined by adding 2 to the number of rings visible on the horn. Thus an animal showing 3 distinct rings on the horn is considered to be about 5 years old. It is possible that a dishonest owner may by scraping remove one or more rings from the horns, but there will usually remain some evidence by which it can be seen that the condition is not normal.

Another method of estimating the age of cattle is by their teeth. Cattle usually have twenty teeth on the lower jaw

and twelve on the upper jaw. Fig. 3 shows the arrangement of these teeth. The front teeth in the lower jaw are known

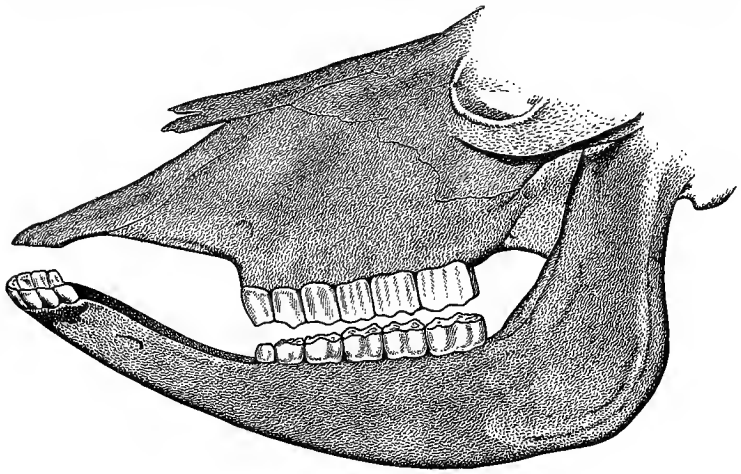


FIG. 3

as *incisors* and the back teeth of the upper and lower jaws are known as *molars*, but usually only the former are considered in estimating age. Animals of the bovine species have no incisor teeth in the upper jaw. The calf is usually born with all the temporary, or milk, incisor teeth up, that is, through the gums. The milk teeth are later replaced by permanent teeth, which are easily distinguished from the temporary teeth by their larger size. Fig. 4 shows the incisor teeth of a bovine and indicates the order in which the milk teeth are replaced by permanent teeth. The first milk teeth to be replaced by permanent ones are the middle pair *a*; next are the first intermediates, *b*; next, the second intermediates, *c*; and lastly, the outer, or corner, teeth *d*. The first, or middle pair of permanent incisors, appear at about 18 months of age, and

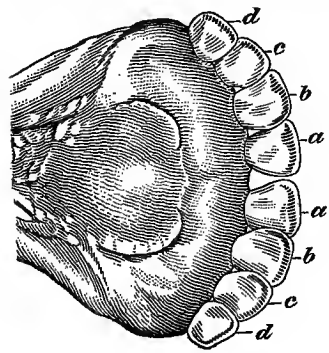


FIG. 4

the succeeding pairs appear at intervals of about 9 months. Thus two pair of permanent teeth indicate an age of about 27 months; three pair, an age of 3 years; and four pair, an age of 3 years and 9 months.

It should be understood that these statements are for averages, and that individuals frequently vary considerably from these averages. From the time of the appearance of the corner incisors there is little change in the appearance of the teeth until the animal begins to fail in physical vigor, which ordinarily is about the age of 8 or 9 years. It is therefore difficult to make an estimate of the age of cattle by the appearance of the mouth between the ages of 4 and 9. As cattle increase in age, the teeth shrink from each other and drop out. Many cows are, however, able to thrive even after all the incisor teeth have been lost.

SELECTION OF THE DAIRY BULL

15. In practically all cases, a dairyman will find it to his advantage to select a pure-bred bull for use in his herd. Breeders frequently refer to the bull as constituting half of the herd, this being a terse way of indicating his importance. Inferiority of any individual cow affects only the offspring of that particular animal, but inferiority of the bull is reflected in the offspring of all the cows that he serves. For this reason the beginner in dairying will do well to exercise care in selecting a bull and pay a reasonable price for an animal that is suitable for his purpose. Many dairymen make the mistake of using immature bulls of mixed or unknown breeding. In such cases, a yearling bull is usually turned out with the herd about the first of June and allowed to run with the cows for 2 or 3 months. By this time most of the cows will have become pregnant and the bull is then fattened and sold at a price little if any below his first cost. By this system, the dairyman has the use of the bull practically free, and furthermore he does not have the expense and trouble of keeping a bull during the rest of the year. However, the disadvantages of this course far exceed its advantages. High

quality of offspring cannot be obtained unless a sire capable of imparting the desired qualities is selected. The most satisfactory way to judge the value of a dairy bull is by an examination of his offspring to see if they possess the qualities desired. This requires that the bull selected be not less than 4 years old, for before that age his first offspring will not be sufficiently developed to give satisfactory indications of their merit. A bull of this age is, of course, more difficult to control and more expensive to keep than a yearling, but if he is a good animal he is worth many times the extra trouble and expense.

As a guide in the selection of a dairy bull, much has been made of such milk signs as rudimentary teats, milk veins, escutcheon, etc., just as these signs have been overemphasized as indications of superior productive power in cows. Although these so-called milk signs may be of some value in selecting a bull, they are by no means to be set against the producing powers of a bull as shown by the quality of his female offspring.

The discussion of the qualities that pertain to constitution, temperament, etc., under the selection of dairy cows will apply to the selection of bulls, except, of course, those characters that are strictly female in their nature.

Good dairy sires should possess a strongly masculine appearance. The chief indications of masculinity are seen in the head and neck, both of which should be sturdy and rugged. The eyes should be prominent and not too close together, the jaws strong, and the nostrils clean and of good size. There is also a certain resolute appearance, vigor, alertness, and energy of movement in the strongly masculine bull that is easily recognized though difficult to describe.

SYSTEMS OF DAIRYING

16. In a general way, it may be said that there are two systems of dairying, and in considering the establishment of a dairy herd it is necessary to take into account the system under which it is proposed to conduct the dairying operations. In one system, calves are practically disregarded and every effort is concentrated on the production of maximum quantities of milk. In the second system the condition is reversed, the production of a large number of calves being the primary consideration and milk yield a secondary matter. Sometimes a combination of the two systems is found advisable.

17. Dairying for Milk Production.—In dairy herds that are maintained primarily for milk production, the question of breed is of less importance than if the principal profit is to be derived from the production of calves. In the first case, the herd will, as a rule, be made up of grade cows rather than pure-bred cows. The usual plan is to buy a pure-bred bull and cross him on native cows for the production of the grade animals and in this way the question of breed will come up for consideration. The important dairy breeds have been described and illustrated in another Section, and, although there is no doubt that some breeds are better fitted for certain conditions of soil, climate, etc. than are others, nevertheless the matter of the choice of breed may be left to individual preference. In almost any location the dairyman may choose a breed for which he has a particular liking and be reasonably assured that with proper management a successful working herd can be established.

The herd of grade cows may be maintained in two ways: first, by the purchase of mature animals from time to time to replace those cows whose usefulness has passed; and second, by raising calves to take the place of old cows that are no longer profitable. There are many conditions under which

the first-mentioned system may be advisable. Some of these are a desire to have the herd composed of cows in their full productive capacity; abundant opportunity near at hand for selecting and purchasing new cows; a reasonably good market for cows that are undesirable; and some degree of skill in selecting and purchasing new animals. Where some or all of these conditions prevail, this may be the easiest and cheapest way of maintaining a herd of high productive capacity. Under the system in which calves are raised to take the place of worn-out cows, the herd will always contain numerous young animals that have not reached full development of the milk-secreting functions. For this reason a herd maintained under these conditions will seldom equal, in average production per cow, a herd maintained by purchasing mature cows. On the other hand, a greater degree of uniformity among the animals of the herd may be obtained by raising calves. If land is abundant and cheap, the cost of raising a calf to maturity will be considerably less than that of purchasing an animal outright.

Through force of circumstances most dairymen are compelled to rely to a large extent on the latter method, that is, the raising of calves as a means of keeping up the number of cows in the herd, in which case the selection of the bull as a sire for these calves becomes an important consideration. In most cases, the dairyman will find it to his advantage to buy a bull, although in establishing a herd it is sometimes possible to economize by securing the services of a suitable bull belonging to a neighboring herd. In the purchase of a bull, close attention should be given to the points mentioned in the discussion of the selection of a bull. The beginner should avoid the common mistake of using a bull of inferior or mixed breeding. Modern dairymen recognize the fact that money judiciously spent in the purchase of a good pure-bred bull is a paying investment.

18. Dairying for Calf Production.—Maintaining a dairy herd chiefly for calf production will seldom prove profitable unless the calves can be sold as pure-bred animals, and hence

at a higher price than could be obtained for calves of mixed breeding. Under these conditions, the establishment of a herd involves the purchase of pure-bred cows and usually a pure-bred bull. The first consideration in establishing a pure-bred herd is the selection of a breed, and, as already pointed out, this is largely a matter of individual preference. A highly productive herd can be established with any of the dairy breeds. There is, perhaps, one consideration in selecting a breed for such a herd as is under discussion that does not apply in selecting a grade herd. It is the matter of securing a market for the pure-bred calves produced. As a rule, it will be to the advantage of the beginner to select a breed that is fairly well represented in his locality, as buyers are naturally attracted to localities where a large number of animals can be inspected. It may, therefore, be said that, other things being equal, it is best to choose the breed that is most extensively raised in the locality where the herd is to be established. A breeder who is isolated from others that are engaged in his same line is at a serious disadvantage in attracting customers.

In purchasing the foundation herd, the beginner may proceed in one of several ways, depending on the capital and equipment he has available. If he has ample capital and adequate buildings, land, etc., he will perhaps find it desirable to purchase immediately a sufficient number of mature animals of the breed selected to stock the farm. This procedure is likely to require considerable outlay, for such animals usually command a high price. Moreover, the buyer will usually find that by buying in this way he has acquired a greater or less number of animals not fully up to his expectations in regard to breeding qualities and milk production, and it will be necessary to dispose of these animals within a few years, usually at a sacrifice.

If capital and equipment are somewhat limited, a start may be made by purchasing a few animals, perhaps only one or two cows and, if necessary, a bull; and the herd gradually increased by adding desirable calves as they approach maturity. If the first individuals are of high quality and care

is taken in the selection of a sire, this method is an excellent one for the establishment of a herd, although it requires considerable time.

19. In some cases a dairyman will find it desirable to adopt a course intermediate between that of buying the entire herd outright and that of starting with only a few animals. For example, the man who proposes to establish a pure-breed dairy herd may find it convenient to purchase one-third or one-half as many cows as he intends to keep ultimately and with offspring from these gradually increase the herd to the desired size. In the purchase of this pure-bred stock, the age of the animals will be an important consideration. It is likely that females between the ages of 15 and 30 months will prove the best investment. Such animals will begin production in a short time, and, being still immature, can be bought for considerably less than fully matured cows. Very young calves can seldom be bought much cheaper in price than yearlings, since the owner will usually demand for them the prices that their pedigrees warrant, regardless of the cost of raising them. On the other hand, animals that are fully matured and have established a record of production will almost invariably command a high price. Moreover, few animals reach their full productive capacity until a large proportion of their calves have been produced, and in purchasing such animals the buyer must take into consideration the probability that they will not produce many more calves. It occasionally happens that very old animals, particularly if they have a slight blemish, can be bought at such a low price that will make them a good investment if they can be made to produce even one or two calves. The dairyman with small means who is seeking to establish a herd can frequently take advantage of such opportunities if he is in a neighborhood where a number of large breeders are located, for such breeders are often willing to part with animals of the kind described, because they detract from the appearance of the herd.

Name of Cow Rose No. 18176 For pedigree, see other side

Name and No. of Sire Jolly Lad 27291 Name and No. of Dam Rose of Rookmont 24156

Date Calved Apr. 1, 1895 Identification Marks Ear tag 438 Breeder John H. Jordan

Remarks

Record of Breedings			Record of Produce						
Bred to	Date	Due to Calve	Calved	Sex	Name and No.	Mark	Here state whether retained in herd or sold	Price	
Daisy Lad	Aug 15 1897	May 26-98	May 29	Bull	Dow E. 32982	Tag 471	Sold to Hurd & Jones, Oct 1900	96	00
" "	Sept 1-98	June 12 99	June 10	Cow	Lillian B	Tag 480	Kept in herd — see page 36		

FIG. 5

MISCELLANEOUS INFORMATION

20. Breeding Records.—The advantage of keeping written records of each animal of the herd, covering parentage, birth, services, offspring produced, and other details are so obvious that it is scarcely necessary to mention them. In small herds it is, of course, possible for the owner or the herdsman to carry many of these details in his mind; but even in such cases there is always the possibility of lapses of memory or the absence of the person who knows the facts. Therefore, the dairyman who purposes to conduct his operations on a business basis will make provisions for maintaining written records of the animals of his herd. The form of keeping such records is not essential, although it is, of course, an advantage to have the information in shape for convenient reference. A variety of systems have been devised and offered to breeders in the form of blank books and cards and may be purchased from dealers in such supplies.

Doubtless any of these will be found satisfactory, but at the same time it is likely that any breeder can, with a little study and consideration, devise a system that will suit his own requirements better than any he might purchase from others. The blank form illustrated in Fig. 5 is one that has been found satisfactory in practical use. An examination of it will give a good idea of the more important facts it is desirable to embody in the records. The form shown has the advantage of being easily adapted for use in keeping records of other domestic animals by making a few changes.

Before accurate records can be kept, it is necessary to provide a means by which it is possible to identify each animal of the herd. Metal ear tags are in general use for this purpose and are generally satisfactory, although they cannot be entirely relied on, because of the fact that they are frequently lost from the ears. If, however, care is taken to replace promptly lost ear tags there is little difficulty in

making this system satisfactory. If it is desired to avoid mutilating the ears, a leather strap bearing a metal tag may be placed around the neck.

A record of the date each cow of the herd is served is one of the most important details to be recorded. This information is required by most stock breeders' associations before offspring of the service will be admitted to registry; it is also a useful guide to the breeder, as it enables him to know approximately when calving will occur. There is, as a rule, no difficulty in knowing the date of service of mature animals, because they do not have access to the bull except at the will of the herdsman; but in the case of heifers there is frequently some doubt as to the exact date of service, due to the fact that heifers are often turned out to pasture with the bull. In all cases of this kind the date of turning out and the date of taking up should be recorded, in the absence of more specific data. Some associations will accept statements of pasture service for registration purposes.

21. Advertising the Herd.—After having established a herd and begun operations, the dairyman must take steps to make his herd known in order that he may have a market for his surplus animals. This means that more or less advertising must be done. No very explicit directions for advertising a dairy herd can be given here, but a few general facts may be of assistance to the beginner. It is acknowledged that strict integrity is essential in all permanently successful advertising, and in the phase under discussion this is especially true. The breeder who has made himself known as one whose advertising may always be relied upon has in this reputation a very valuable asset.

There are three chief avenues through which a dairy herd may be advertised to the public. These are, first, the public press, particularly the agricultural journals; second, exhibition at fairs and expositions; and third, circulars. All of these methods are valuable, but the conditions in any particular case may make one more suitable than another. In this matter as well as in the preparation of the advertising

copy and other such details the dairyman must use his own judgment. Good taste in the preparation of printed advertisements, letterheads, and cards adds much to their attractiveness. If the dairyman is in doubt regarding some of these details the advice of a competent advertising man or printer will be helpful.

There are many successful breeders of dairy cattle who do not exhibit their animals publicly and yet have no difficulty in disposing of their surplus animals. On the other hand, many regard this kind of advertising as superior to all other kinds and make it a rule to exhibit at all leading dairy shows.

The public exhibition of dairy cattle is on a somewhat different basis from that of beef cattle, in that it is not necessary to show the former in a high condition of flesh. By this it is not meant to say that dairy animals are not shown fat, but rather that the best judges will make awards irrespective of the condition of the animals. The dairy cow makes the best appearance in the show ring when she is in good working order, that is, showing a large udder development and a loose, pliable skin, indicating a well-nourished condition but with no superfluous fat. The mature cow is in the best condition for show when she is in full milk, say at from 1 to 3 months after calving. It is perhaps needless to say that all cattle should be shown absolutely clean so far as currying can make them so. The practice of shampooing animals with soap and water and then covering them with a blanket is very common. This treatment serves to stimulate the skin and promote secretions and make both the skin and the hair soft and pliable. Clipping the hair 2 or 3 weeks before showing greatly improves the appearance of the animal.

The matter of training an animal for shows is quite as important as the preparations mentioned. The training should be such that the animal can be handled and led and that it will stand quietly and naturally, with head erect. These qualities add much to the general appearance of the animal in the show ring. A week or 10 days of constant practice before the beginning of the show season will do much

to bring about the desired results, and the time and effort required to do this can scarcely be more advantageously spent.

22. Sale of Surplus Stock.—Surplus stock may be disposed of at public or private sale. Public auctions of pure-bred stock are common and, as a rule, they are satisfactory to both buyer and seller. A successful public sale, however, requires a large expenditure for special advertising and the preparation of a catalog. For this reason it is customary for a number of breeders to combine in holding a public sale, thus reducing the cost to each one.

The actual value of a pure-bred animal is a point difficult to determine, because the laws of supply and demand that govern the price of ordinary products do not have full play in such cases. It has been tersely stated that a pure-bred animal is worth what its owner may demand for it or what the prospective purchaser is willing to pay. The custom of selling pure-bred livestock at public auction goes far toward establishing a fair market value for such animals. At public sales the animals are offered for public appraisal, and the judgment of breeders assembled at the sale determines, to a large extent, the selling price. These sales, are, as a rule, conducted on a fair, straightforward basis, hence the inexperienced dairyman may buy in this way with a fair degree of security, if his judgment is good, and if he will avoid being carried away by enthusiasm over popular strains and by the spirit of contest that frequently enters into such sales. It is true that the buyer at a private sale has the advantage of more time and better opportunity to examine the animal and its ancestry and to make a selection than at a public sale. The buyer will, however, usually pay a somewhat higher price at a private than at a public sale and, moreover, it is seldom possible to purchase any considerable number of animals at private sale without the expenditure of considerable time and money in going from place to place.

The sale of pure-bred stock by correspondence is a growing practice. Many animals may be disposed of in this way, particularly if the owner has established a reputation for

honesty and integrity. The breeder who desires to build up a large correspondence business must be exceptionally careful in regard to statements he makes to prospective buyers. It is extremely easy to make a written description somewhat overdrawn and of such a nature that the buyer will be disappointed on seeing the animal. Without doubt, many sales by correspondence are disappointing to the buyer. The breeder will find it to his advantage to keep the good-will of the buyer, even if it is necessary to have the animal returned to him at his own expense.

There are always certain animals in the herd that the owner wishes to retain for one reason or another, and frequently these will be the very ones that the buyer at private sale wants. If the owner refuses to put a price on them the buyer is likely to refuse to make selections from the remainder of the herd. For this reason it is perhaps advisable to put a price on all animals, desirable and undesirable, making the figure high enough on those it is sought to retain that the owner can well afford to let them go if the buyer does decide on one or more of them.

23. Shipping of Pure-Bred Cattle.—The dairyman who is raising pure-bred animals frequently has occasion to ship one or two individuals to purchasers. In such cases, express shipment is usually cheaper than freight and, of course, more prompt. Crates must be provided for animals to be shipped by express. The crate should fit the animal closely enough that it will not attempt to lie down. All parts of the animal, except possibly the head and neck, should be enclosed. Young calves may be shipped a considerable distance without feeding in transit. If amply fed just before crating, the calf can go 24 or 36 hours without suffering seriously from hunger.

DAIRY-CATTLE MANAGEMENT
(PART 2)

MANAGEMENT OF DAIRY HERDS

MANAGEMENT OF DAIRY COWS

1. Feeding the Dairy Cow.—The feeding of dairy cows does not differ in principle from the feeding of other domestic animals, and the general discussion appearing elsewhere should be considered in connection with the following discussion. The primary object in feeding dairy cows is the production of a maximum quantity of milk for the least expenditure for feed. Some feed is, of course, required for the maintenance of the cow's body, but in most cases this demand is satisfied before that for milk secretion. In the majority of cases a dairy cow will, if sufficiently fed, maintain her body from the nutrients supplied and utilize the surplus for milk production and for the development of the fetus when she is pregnant. Occasionally, a case is seen in which a cow produces milk at the expense of the maintenance of her body but such a condition is unusual and can never be long continued. Cows vary greatly not only in their capacity to consume and assimilate feed but also in their capacity to secrete milk from a given quantity of feed. Successful feeding of dairy cows necessitates a study of the requirements and capacities of individual animals. It is necessary, however, to take into account feeding standards and the nutritive ratio, digestibility, variety, palatability, succulence, suitability, and relative cost of the various feedstuffs available.

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ENTERED AT STATIONERS' HALL, LONDON

2. Under the conditions that prevail in most dairy sections, a dairyman will usually find it necessary to buy at least a part of the feed required for his dairy cows, and much of his success in the production of milk will depend on the economy and good judgment displayed in the selection and purchase of these materials. The feeds that are bought should be so chosen as to supplement best those produced on the farm. Usually the feeds raised on the farm will consist largely of roughage and fodders, most of which will have a low protein content. Hence, a dairy farmer finds it advisable to purchase concentrates, especially those that are rich in protein. The list of grains and mill feeds suitable for this purpose will be found in *Principles of Feeding*, and from this list a dairyman may select some that fulfil his requirements and that may be purchased in his locality most economically, taking into account the analysis. Some of the concentrates extensively used by dairymen are bran from wheat and other grains, cottonseed meal, corn products known as gluten feed, gluten meal, etc., and linseed meal. In the modern processes of milling and other treatment of various grains there results a large assortment of by-products that are marketed for stock-feeding purposes. Some of these by-products are well adapted for feeding dairy cows, but on the other hand there are many that are comparatively worthless, although cows eat them readily. Unscrupulous manufacturers often mix these worthless materials with others and in this way dispose of them at a profit. Fortunately, there are in most states where by-product feeds are extensively used, laws designed to protect the feeder from this kind of imposition by requiring the manufacturer to guarantee a certain percentage of nutritive elements and a certain minimum percentage of worthless material. It therefore behooves a dairyman to familiarize himself with the laws of his state governing this matter and to ascertain the guaranteed composition of the feed he is buying. In addition to concentrates considered in the preceding paragraphs, certain other feeds are valuable for feeding to dairy cows. Pasture, during the season that it is available, furnishes an ideal feed

and should be utilized whenever practicable. A discussion of the various pasture plants and grasses appears in another Section. Soiling as a method of supplying cows with green feed is a favorite method with many dairymen and one that is particularly adapted to places where only a small area of land is available and the dairyman's operations are necessarily intensive. The silo is undoubtedly one of the most valuable adjuncts to the successful dairyman's equipment. It makes possible the feeding of green succulent feed during the winter months. Root crops furnish another means of accomplishing this same end. Sections devoted to soiling, silos, silage, and root crops give full particulars regarding the crops suitable for these purposes and methods of handling them.

3. The following rations are offered as suggestions to be modified to suit individual conditions. One or more of them may be suitable for some cases and frequently one ingredient may be substituted for another provided the two are of approximately the same composition. With these rations as a guide, a dairyman can easily make up from the feedstuffs he has available an economical and satisfactory ration for the cows of his herd.

SUGGESTED RATIONS

RATIONS	POUNDS
No. 1:	
Mixed hay	20
Dried distillers' grains	4
Hominy chop	2
Wheat bran	2
No. 2:	
Mixed hay	10
Corn silage	40
Gluten feed	4
Corn meal	2
Wheat bran	2
No. 3:	
Mixed hay	15
Mangels	40
Cottonseed meal	2
Hominy chop	4
Wheat bran	2
No. 4:	
Mixed hay	10
Dried beet pulp	5
Cottonseed meal	2
Hominy chop	4
Wheat bran	2

SUGGESTED RATIONS

RATIONS	POUNDS
No. 5:	
Clover or alfalfa hay	15
Corn silage	25
Oats	3
Wheat bran	3
Buckwheat middlings	3
No. 6:	
Timothy hay	10
Corn silage	40
Dried distillers' grains	4
Cottonseed meal	2
Hominy chop or corn meal	2
No. 7:	
Timothy hay	10
Corn silage	40
Gluten feed	4
Linseed meal	3
Hominy chop or corn meal	1
No. 8:	
Alfalfa hay	20
Corn	3
Oats	3
Wheat bran	2

4. During the time that intervenes between drying off, that is, cessation of the milk flow, and parturition some special attention is necessary in the matter of feeding a pregnant cow. A liberal ration of stimulating feeds, particularly if they are of such a nature as to tend to create a feverish condition, is objectionable not only because it makes the matter of drying off difficult but also because it is conducive to certain inflammatory troubles at calving time. This latter subject is one that is more fully considered elsewhere. It has been demonstrated that an abundance of coarse, nutritious fodder, such as good pasture grass or hay containing considerable quantities of clover or other legumes, is sufficient to maintain a cow and its growing fetus, and there are many dairymen who consider that this is the most rational method of feeding at this time. Other dairymen have found that it is possible to feed the dry, pregnant cow in such a way that she will lay up in her body a reserve of material that will go toward the production of milk after calving, and many dairymen do not hesitate to fatten their cows preparatory to the calving period. This can be done most satisfactorily by supplying feeds that are nourishing and easily digestible but that are not too concentrated

or feverish in their effects. If clover or alfalfa hay, wheat bran, oats, and roots are used there is little danger of unfavorable results; but corn, cottonseed meal, and gluten feed should be rigorously excluded. A further safeguard is in keeping the bowels constantly loose, for which purpose the liberal use of old-process linseed meal is of advantage. The cow should reach calving time completely dry, in good flesh, with the bowels open, and with no feverish symptoms.

5. Breeding the Dairy Cow.—There is considerable difference of opinion among dairymen as to the age at which it is desirable to breed a dairy heifer. The improved dairy breeds are extremely precocious, and a young dairy heifer will often show evidence of sexual maturity as early as 6 months of age, but she does not reach her full growth and development until about 5 years of age. If bred at the age of 6 months her first calf will be delivered when she is about 15 months old, but it is questionable whether a heifer can produce a calf at such an early age without materially interfering with her own growth and development. It is usually considered an advantage to secure early development of the milk-producing function, hence heifers are bred comparatively early in order that the function may be established while the animal is young. Probably the most general practice is to have the heifer drop her first calf when she is about 2 years of age. A heifer calving at this age will have no difficulty in reaching her full development if she has had good feed and care. It is important, however, that an abundance of good feed should be given to a heifer after she has dropped her first calf. Many who advocate early calving prefer to make the interval between the first and the second calving longer than the normal time, say from 15 to 18 months. In support of this practice it is claimed that this extra time gives opportunity for growth and development and for establishing the milk-producing function. Another condition that warrants fairly early breeding of the heifer is the fact that in some breeds the recurring periods of heat interfere to a greater or less extent with the development of the young

animal. The periods of heat begin sometimes when the heifer is only 6 or 7 months old. Each period lasts from 2 to 4 days, during which time the heifer is feverish, uneasy, and irritable, and the recurrence every 3 weeks may have a considerable effect in retarding growth.

Since heat does not occur during pregnancy, it is considered advisable, in the case of heifers that reach sexual maturity early and are particularly excitable during heat, to breed them even as early as 9 months of age. In the case of heifers that develop slowly and do not reach sexual maturity at an early age, it is probably advisable to delay breeding until they are from 18 to 24 months of age. Many such slow-developing heifers eventually make very productive cows.

Normally, the cow produces a calf at intervals of about a year. Since the gestation period in cows is approximately 9 months, it is evident that they must be bred about 3 months after calving if they are to produce a calf each year. In a dairy in which the production of calves is the chief object it is likely that this is the practice that will be followed, but if a maximum milk yield is sought it may be found desirable to depart from the schedule to a greater or less extent.

A dairy cow should give milk up to within 2 months or 6 weeks of calving. After the sixth month of pregnancy the demands of the growing fetus are such as to diminish markedly the flow of milk. In cases in which it is desired to have the cow make a high record of milk production for a year, breeding may be delayed until the expiration of the specified time. This will result in the calves being dropped at intervals of from 16 to 20 months. When breeding is managed on this plan for several successive years there is a tendency to induce irregularity of breeding and of course fewer offspring are produced, both of which results are objectionable. Except in the case of a cow making a very high record, the chances are that it will be to the advantage of the dairyman to sacrifice the yearly milk yield rather than to delay breeding to such an extent as to obtain but two calves in 3 years and run the risk of establishing a habit of irregular breeding.

6. Signs of Pregnancy.—The most reliable sign of pregnancy in a cow is the discontinuance of the regular periods of heat. Occasionally, heat occurs after pregnancy, but this is so uncommon that it need not be taken into consideration. As the fetus develops in the uterus it normally takes a position in which the head is close to the abdominal wall of the dam, well down on the right side. An experienced person will, by careful manipulation, be able to feel the hard, nodular prominence of the fetal forehead against the side of the cow as early as the fifth month of pregnancy, but this requires some skill, particularly if the cow is at all fleshy. An inexperienced dairyman will probably not be able to detect the head until about the seventh month, and by this time the fetus will have become large enough to distend the abdomen so that pregnancy will be evident from the general appearance of the latter. After about the sixth month the muscular movements of the fetus become sufficiently marked to be evident to the eye, especially on the right side of the cow. They are best seen after the cow has been exercised or after she has taken a drink of cold water.

A further indication of pregnancy is the rapid diminution in the flow of milk. This occurs sometimes as early as the fifth month, but usually about the sixth or the seventh month.

7. Care of a Pregnant Cow.—A dairy cow that is bred to produce offspring every year will normally yield milk during fully seven months of her pregnancy. During this time there is no necessity for special care, feed, or treatment other than what would normally be given to a working herd of dairy cattle. In other words, the modern dairy cow has been so developed as to be able to produce milk in commercially paying quantities and at the same time nourish and develop a growing fetus.

A pregnant cow should have abundant feed, at least moderate exercise, gentle treatment, and her bowels should be kept in good condition, neither too constipated nor too loose, for these are cardinal principles to be observed in handling any dairy cow. Some special attention should,

however, be given to the pregnant cow between the time of drying off and calving. It is generally conceded that a cow should be dried off for a time before calving, although some cows can be so managed as to give milk continuously. As a matter of fact, there are many cows in which the habit of giving milk is so strongly developed that when sufficient feed is given to them to keep them in good physical condition it is extremely difficult to dry them off. Some dairymen prefer to feed such cows abundantly and milk them continuously, allowing no dry period whatever rather than run the risk of injuring the udder by enforced drying off. But whatever may be the habit of the cow with regard to the secretion of milk, there is no question but that there is an advantage to the animal, so far as further secretion is concerned, in having her completely dry for at least a month before calving. If a cow goes dry at this time and the udder becomes entirely empty, she will make greater preparations for secreting milk after the calf is dropped, and will yield more milk than if she had given milk up to the time of calving. Furthermore, in the last weeks of pregnancy, the milk is usually changed in composition and strong in flavor, being undesirable for human use, even though it may still be secreted abundantly.

8. In most cases, drying off is not a difficult matter, but the manner in which it is done is likely to have a marked effect on the further usefulness of the cow. The object sought is to produce entire cessation of the secretion of milk and inactivity of the secreting glands. There are two factors that tend to check secretion of milk: first, withholding feed; and second, allowing the udder to become distended with milk. These two factors are largely depended on to dry off a cow, but both may be so applied as to injure the cow. Some dairymen, in their efforts to dry off a cow, cut the feed supply to such an extent that they literally starve her dry. Cows in which the milk-producing function is so strong that it is necessary to resort to such drastic treatment are usually in thin flesh by the seventh month of pregnancy. The effect

of the starving process is to reduce the animal still further in flesh, and even if this does not materially injure the growing fetus some injury must result to the cow, for she does not have sufficient time after the milk flow ceases to recuperate her strength for resuming the secreting process after parturition. Much can be done toward checking secretion without materially reducing the supply of nutrients. This is accomplished by feeding dry fodder instead of succulent feeds. If this course is followed, a cow may be fed at least three-quarters of her usual grain ration and there will be no marked tendency to keep up the milk flow. In selecting grains to be fed at this time, it is important to choose those that do not tend to stimulate milk production. Ground oats and a small quantity of corn are satisfactory for the purpose mentioned. In exceptional cases it may be necessary to reduce the grain ration very materially for a few days or a week, but it should be increased again as soon as milk secretion has ceased.

9. Perhaps the most important consideration in drying off a cow is the treatment of the udder. Irregularity of milking and the continued presence of milk in the udder tend strongly to check secretion, but it should be understood further that milk in the ducts and vessels of the udder becomes an irritant and tends to set up inflammation if it remains there beyond the normal period. The aim should be to check secretion as rapidly as possible and at the same time to avoid causing inflammation or undue irritation. A course that has been found satisfactory is to milk the cow once a day instead of twice a day, for 3 days. This will ordinarily reduce the milk flow about one-half; that is, at the end of the third day she will be giving about the same quantity of milk at a single milking that she was giving at a single milking when she was milked twice a day. The cow should now be milked at irregular intervals and the condition of the udder watched carefully. When the udder has become fully distended all the milk must be drawn out and the organ allowed to become distended again and, if possible, permitted to remain so for a longer time than in the preceding case.

When milking is done it should be thoroughly done, that is, all the milk should be drawn. Some dairymen practice drying off by incomplete milking, or, in other words, removing only a part of the milk at successive milkings. This course is not advisable, however, because the usual result is that the cow never becomes completely dry. Even if inflammation does not result from this condition it is a distinct disadvantage when the cow begins to make up her udder in preparation for calving. If the cow is milked clean at constantly increasing intervals the udder will be completely empty when the secretion finally ceases. Usually, a cow can be dried off within 2 weeks by the latter method, but the animal should be watched carefully for some time after this, and if the udder fills up, as it sometimes will, it should be milked out.

10. Care of a Cow During Parturition.—If the dairyman has kept accurate records of service of his cows, he can easily determine from a gestation table the approximate date on which delivery may be expected. Table I is a convenient form of gestation table in which the second column shows the probable date of birth, when the service was made on the date opposite in the first column. For example, if a cow was served on January 10 the calf is likely to be born on October 21, and a cow served on June 26 may be expected to calve on April 6. The dates given for calving are but approximations, and delivery may occur a few days earlier or later. The table shown is made up on the basis of a gestation period of 285 days, although some authorities consider 280 days a better average.

11. A week or 10 days before the calf is expected, the cow should be placed in an enclosure by herself. During the summer and early fall there is no better place for calving than a clean pasture or paddock. At other seasons of the year a comfortable, roomy box stall should be provided. Special care should be exercised to see that the stall is clean and sanitary, for many ills that affect new-born calves are directly traceable to filthy stalls and bedding. Before the cow is placed in the stall, all loose litter should be removed

TABLE I

GESTATION TABLE FOR CATTLE

Date of Breeding	Due to Calve	Date of Breeding	Due to Calve	Date of Breeding	Due to Calve
Jan. 1	Oct. 12	Feb. 1	Nov. 12	Mar. 1	Dec. 10
2	13	2	13	2	11
3	14	3	14	3	12
4	15	4	15	4	13
5	16	5	16	5	14
6	17	6	17	6	15
7	18	7	18	7	16
8	19	8	19	8	17
9	20	9	20	9	18
10	21	10	21	10	19
11	22	11	22	11	20
12	23	12	23	12	21
13	24	13	24	13	22
14	25	14	25	14	23
15	26	15	26	15	24
16	27	16	27	16	25
17	28	17	28	17	26
18	29	18	29	18	27
19	30	19	30	19	28
20	31	20	Dec. 1	20	29
21	Nov. 1	21	2	21	30
22	2	22	3	22	31
23	3	23	4	23	Jan. 1
24	4	24	5	24	2
25	5	25	6	25	3
26	6	26	7	26	4
27	7	27	8	27	5
28	8	28	9	28	6
29	9			29	7
30	10			30	8
31	11			31	9

TABLE I—(*Continued*)

Date of Breeding	Due to Calve	Date of Breeding	Due to Calve	Date of Breeding	Due to Calve
Apr. 1	Jan. 10	May 1	Feb. 9	June 1	Mar. 12
2	11	2	10	2	13
3	12	3	11	3	14
4	13	4	12	4	15
5	14	5	13	5	16
6	15	6	14	6	17
7	16	7	15	7	18
8	17	8	16	8	19
9	18	9	17	9	20
10	19	10	18	10	21
11	20	11	19	11	22
12	21	12	20	12	23
13	22	13	21	13	24
14	23	14	22	14	25
15	24	15	23	15	26
16	25	16	24	16	27
17	26	17	25	17	28
18	27	18	26	18	29
19	28	19	27	19	30
20	29	20	28	20	31
21	30	21	Mar. 1	21	Apr. 1
22	31	22	2	22	2
23	Feb. 1	23	3	23	3
24	2	24	4	24	4
25	3	25	5	25	5
26	4	26	6	26	6
27	5	27	7	27	7
28	6	28	8	28	8
29	7	29	9	29	9
30	8	30	10	30	10
		31	11		

TABLE I—(*Continued*)

Date of Breeding	Due to Calve	Date of Breeding	Due to Calve	Date of Breeding	Due to Calve
July 1	Apr. 11	Aug. 1	May 12	Sept. 1	June 12
2	12	2	13	2	13
3	13	3	14	3	14
4	14	4	15	4	15
5	15	5	16	5	16
6	16	6	17	6	17
7	17	7	18	7	18
8	18	8	19	8	19
9	19	9	20	9	20
10	20	10	21	10	21
11	21	11	22	11	22
12	22	12	23	12	23
13	23	13	24	13	24
14	24	14	25	14	25
15	25	15	26	15	26
16	26	16	27	16	27
17	27	17	28	17	28
18	28	18	29	18	29
19	29	19	30	19	30
20	30	20	31	20	July 1
21	May 1	21	June 1	21	2
22	2	22	2	22	3
23	3	23	3	23	4
24	4	24	4	24	5
25	5	25	5	25	6
26	6	26	6	26	7
27	7	27	7	27	8
28	8	28	8	28	9
29	9	29	9	29	10
30	10	30	10	30	11
31	11	31	11		

TABLE I—(*Continued*)

Date of Breeding	Due to Calve	Date of Breeding	Due to Calve	Date of Breeding	Due to Calve
Oct. 1	July 12	Nov. 1	Aug. 12	Dec. 1	Sept. 11
2	13	2	13	2	12
3	14	3	14	3	13
4	15	4	15	4	14
5	16	5	16	5	15
6	17	6	17	6	16
7	18	7	18	7	17
8	19	8	19	8	18
9	20	9	20	9	19
10	21	10	21	10	20
11	22	11	22	11	21
12	23	12	23	12	22
13	24	13	24	13	23
14	25	14	25	14	24
15	26	15	26	15	25
16	27	16	27	16	26
17	28	17	28	17	27
18	29	18	29	18	28
19	30	19	30	19	29
20	31	20	31	20	30
21	Aug. 1	21	Sept. 1	21	Oct. 1
22	2	22	2	22	2
23	3	23	3	23	3
24	4	24	4	24	4
25	5	25	5	25	5
26	6	26	6	26	6
27	7	27	7	27	7
28	8	28	8	28	8
29	9	29	9	29	9
30	10	30	10	30	10
31	11			31	11

and the quarters disinfected in accordance with directions given elsewhere. Clean bedding, preferably straw, should then be supplied and all droppings and dirty bedding removed once or twice daily during the time the cow and calf are in the stall.

The external appearance of the cow may be relied on to indicate with a fair degree of certainty the approach of parturition. Usually, before the birth of the calf, the udder begins to enlarge and fill up. This process is known as *making up* the udder and is more gradual in the heifer than in the old cow. Pregnant heifers will begin to show enlargement of the udder as early as the sixth month of pregnancy. In old cows, however, the udder will, as a rule, remain loose and flaccid until about 2 weeks before calving, at which time it begins to enlarge and fill up. This condition is generally considered a safe indication of the approach of parturition. Later the teats fill up and milk may be drawn from them. When this latter condition appears the calf will ordinarily be born within 24 hours. Simultaneously with the filling of the udder, the tissues of the vulva become swollen and the muscular tissues between the root of the tail and the pin bones become loose and flaccid. If at this time there is any indication of constipation the cow should have a liberal dose of Epsom salts, in order that the digestive tract may be cleared. Beyond these details and keeping a general oversight of the cow, the presence of any one at the time of parturition is not necessary or even desirable if the calving is normal. In cases of difficult parturition, due to abnormal presentations and other complications, it is frequently necessary to render the cow some assistance, as directed elsewhere.

12. Within a short time after birth the young calf will require feed, and it is always preferable that it should be allowed to suckle the dam, as the first milk, which is known as *colostrum*, exerts a purgative effect that is beneficial to the calf at this time. Usually the calf will be able to rise to its feet and take its first meal within a short time after

being dropped. If for any reason its efforts to rise are unsuccessful some assistance should be given.

For a few days after calving the cow should receive only a moderate ration, consisting principally of succulent feed. She should also be protected from sudden chill and from excessive heat of the sun. The milk for the first 3 or 4 days will retain its colostrum character and is therefore unfit for human use, but is excellent feed for young calves. Under normal conditions, the milk flow will be thoroughly established in 4 or 5 days after calving, and from that time on the cow may take her regular place in the dairy and receive the same feed and care as is given the other animals of the herd.

MANAGEMENT OF CALVES

13. For the first few days after birth the calf should suckle the dam. Some dairymen take the calf from its mother immediately after birth, claiming that at this time there is less difficulty than later in teaching the calf to drink from a pail. However, calves of the dairy breeds are, as a rule, easily taught to drink, and as the colostrum is unsuitable for other use and admirably adapted to the calf's needs, it is undoubtedly good practice to utilize it in this way. By the time the dam's milk is suitable for human use the vital function of the calf will be well established and it may then be taught to take its feed from a pail. Preparatory to being taught to drink from a pail, the calf should be allowed no feed for about 12 hours. It should then be placed in a corner of a stall where the attendant may secure it by standing astride its neck. A pail of milk freshly drawn from the dam may now be placed on the floor in front of the calf and its nose gently forced into the milk. In most cases the calf will drink at once, particularly if the attendant will insert his finger in its mouth while the latter is immersed in the pail of milk. If the calf does not drink after repeatedly immersing its nose as directed, letting it fast for another 12 hours and then repeating the operation will almost invariably result successfully. As soon as the calf has been taught to drink

it should be fed regularly three times a day. At each feeding the calf may be given from 3 to 6 pounds of freshly drawn milk. The exact quantity will depend on the size and vigor of the calf, and the quantity should be increased gradually and regularly as the animal grows. No fixed rule for this can be given; the judgment of the feeder must determine the quantity for each case. If possible, the calf should receive whole milk up to the time it is 2 weeks old. At this age, if it is thrifty, skim milk may be substituted by degrees, taking 3 or 4 days to make the change and continuing the feeding on the same plan as for whole milk. Any tendency toward diarrhea, or scours, is an almost certain indication of overfeeding and that the milk ration should be reduced.

14. It is desirable to feed skim milk warm and sweet, although some dairymen feed cold milk in summer, and sour milk is sometimes fed to calves. In either of these cases it is advisable to make the change from warm sweet milk to cold or sour milk a gradual one. In all cases it is important that the feeding be regular and the feeding vessels kept scrupulously clean.

If several calves are confined in the same enclosure they are likely to form the pernicious habit of sucking one another's ears, flanks, and rudimentary udders. The latter organ may be seriously injured by this practice, hence it is advisable to keep each calf in a separate enclosure or at least be on the lookout for such tendencies and promptly isolate calves that develop them. Sometimes the inclination to suck any available object may be checked by opening the calf's mouth and placing in it a handful of wheat bran. This gives the animal something to chew and tends to establish early the habit of eating dry feed. All things considered, calves are better off, during the time they are being fed on milk, if they are kept in stalls than if they are turned out on pasture. The grass they eat on pasture does them but little good and to a certain extent it destroys their appetites for milk. Moreover, on pasture they are exposed to the attacks of flies and other insects. When the calf is 3 or 4 weeks old it will begin to

nibble feed if any is available. At this time small quantities of early cut, well-cured clover hay may be given and the calf encouraged to eat all it wants of this feed. Concentrated feed in the form of wheat bran, ground oats, etc. may also be placed in boxes in order that the calf may acquire a taste for such feeds. For a grain ration after the calf has begun to eat, nothing is superior to a mixture of equal parts, by weight, of wheat bran, corn meal, and either whole or ground oats, with 10 per cent. of old-process linseed meal. For example, 10 pounds each of bran, corn meal, and oats, and 3 pounds of linseed meal would be the proper proportions. This ration may be continued until the calf is 5 or 6 months old, at which time the milk ration may be gradually withdrawn. At all times a careful watch should be kept and at any tendency toward scours the feed should be reduced. When the milk ration is cut off, it is well to feed some silage, roots, or other succulent feed. Some dairymen recommend that if the calf is ultimately to become a dairy cow it should be kept thin in flesh, in order that no tendency toward beefiness may be developed. However, there is little or no evidence to indicate that the fat a calf puts on during the first 6 months of its life will have any effect on its tendency toward beef or milk production. Any young animal that is sufficiently nourished to make good growth will tend to become fat, but this so-called *baby fat* almost always disappears when the animal approaches maturity. In general, it may be said that there is little danger of getting dairy calves too fat if they are fed in accordance with the directions just set forth, but a heavy feeding of corn meal alone might bring about undesirable results.

From the time the calf is weaned it should be kept in good, thrifty growing condition until it is ready to take its place in the herd. Abundant pasture during the summer should be sufficient in most cases, and during the winter, if the calf is fed all the silage and clover hay it will eat readily, grain feed is hardly necessary. If, however, for any reason growth and development seem delayed and there is apparent lack of thrift, the coarse feeds mentioned should be supplemented with grain as already directed.

MANAGEMENT OF DAIRY BULLS

15. The problem of proper management of the dairy bull is often somewhat perplexing. As a rule, the investment in a bull is several times greater than in any other single animal of the herd, and it is therefore important that he be handled and cared for in the best possible manner. A bull does not reach his full development until he is 4 or 5 years of age, by which time he has usually become large and more or less unruly, if not actually vicious.

16. Methods of Handling a Bull.—Many difficulties in keeping bulls arise from confining them alone in pens or stalls at a distance from other cattle. The common practice is to put the bull in a small, dark stall, visit him only to supply feed and water, and handle him roughly. Under such treatment most bulls will soon become vicious and treacherous. Undoubtedly, the best course in handling a dairy bull is to treat him as if he were in no sense out of the ordinary. During the breeding season it is of course necessary to keep the bull away from the cows, bringing them to him one at a time for service as they come in heat. After the cows are pregnant, it is possible, if a little extra care is taken, to turn the bull out with them, except in the case of a herd that is being managed on the plan that brings the calves at irregular periods throughout the year, when it will probably be impracticable to keep the bull with the cows at any time.

A bull 2 years old or over, when allowed to run with the herd, is very likely to show an inclination to resent the approach of persons, particularly strangers. His pawing and bellowing at such times may, however, be regarded as evidence of his instinctive desire to act as a protector of the cows of the herd and not as signs of ill temper or viciousness. If no attention is paid to them they will soon cease. If, on the other hand, the bull is chastised for such actions he is likely to develop an ugly disposition and become aggressive. No more attention should be given to a bull running at large than is given to other animals of the herd.

When it is necessary to confine the bull, the stall selected should be so located that he can see, hear, and smell the other animals. The stall should, of course, be particularly well constructed to prevent the animal escaping. If the bull is thus confined no attention whatever should be given to his uneasiness, pulling at the halter, pawing, rubbing against the sides, etc. There is no surer way of making a bull mischievous and troublesome than to shout at him and beat him for such actions. Much can be accomplished toward making a bull easy to handle by systematic training and handling from the time he is a calf. If so treated, by the time he has reached his full development he will in almost all cases be obedient and easily managed.

It must not be inferred from the preceding that no precautions are necessary in handling a bull. The temper of a bull is very likely to undergo a rapid change about the time he reaches maturity. No matter how carefully trained and well behaved he has been, sudden ebullitions of temper are likely to occur. The only safe course is always to be on the lookout for such outbreaks. No owner or attendant should ever place himself in the power of a mature bull, no matter how gentle or well behaved the latter has previously been.

As a general rule, bulls should be dehorned in calfhood, at which time the operation is extremely simple and easily performed. As a further precaution, a bull ring, such as may be procured from any dealer in stockmen's supplies, should be placed in the animal's nose, preferably before he reaches maturity. In handling a vicious bull, a stout stick about 3 feet long having a snap affixed to one end is attached to the bull ring by means of the snap. The attendant can easily handle the most unruly bull with this device by keeping his head elevated. No bull can do much damage unless he is able to get his head down.

In large dairy herds in which two or more bulls are kept many difficulties may be avoided by allowing the bulls to run together in an exercise yard. The yard should be of ample size and surrounded by a strong fence, preferably of woven-wire fencing. Bulls confined in this way will, of

course, do more or less fighting, but if they are dehorned there is little likelihood of their injuring one another seriously, and the exercise they get from these encounters will be rather beneficial than otherwise. The plan just described is particularly satisfactory in the case of bulls that have been kept together from calfhood, but even strange bulls of mature age may be brought together and accustomed to this method of handling.

17. Feeding a Bull.—Bulls that are being used for service should be fed a ration fairly rich in protein. A ration that is suitable for milch cows will provide protein enough for the bull. It should be stated, however, that oats are particularly adapted for the needs of service males and may frequently be used to advantage in the ration for the bull when they are considered to be too expensive for the entire herd. Too often the feed for the bull is allotted on the basis that anything is good enough for the bull, and he accordingly receives refuse, such as the leavings from the mangers of other animals. Such a practice is not conducive to the production of strong, healthy calves. The other extreme in feeding bulls, namely overfeeding, must also be guarded against. Sometimes, when bulls are kept confined in a stall, they are fed so liberally and allowed so little exercise that they become excessively fat, a condition that interferes seriously with their usefulness. The correct management as to feeding lies between these two extremes. The bull should have enough feed to keep him in a good, thrifty condition, but not fat. As a rule, he will reach full maturity at about the age of 5 or 6 years. From this time on his weight should be maintained as nearly constant as possible. An excess of extremely bulky feeds should be avoided, as it tends to develop the paunch unduly and to make the animal sluggish and inactive.

18. Use of a Bull.—A young bull may be allowed to serve a few females when he is 15 months old, provided he is in a thrifty and vigorous condition. When he is 2 years old, he may be allowed to serve from forty to sixty cows in a season of 3 or 4 months. If handled in accordance with the above

suggestions, a bull should continue his period of usefulness up to 8 or 9 years of age, and even longer, but his best offspring are usually produced in the period from the time he is 3 years old until he is 7 years old. When a bull becomes impotent, or sterile, it is usually due to errors in feeding and lack of exercise rather than to excessive service.

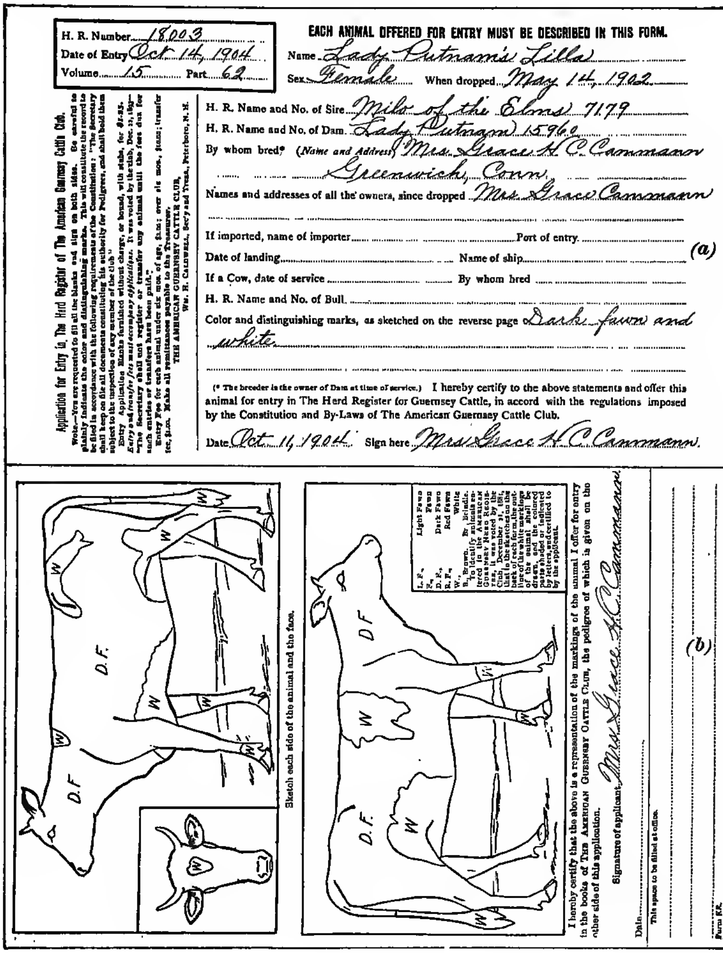
REGISTRATION OF DAIRY CATTLE

19. The first step toward registering an animal is to obtain blanks on which the facts as to its birth, name of sire and dam, and other details may be entered in proper form. Blanks for this purpose are known as *applications for registry*, or applications for entry, and may be obtained from the secretary of the association. In Fig. 1 (*a*) is shown an application for registry in the herd book of the American Guernsey Cattle Club, and in (*b*) is shown the reverse side of the blank, on which the applicant is required to indicate the color markings of the animal in the outline drawings as shown.

If the application blank is properly filled out and the animal is eligible to registry the secretary issues a certificate of registry. One form of such a certificate is illustrated in Fig. 2. The side of the blank shown in (*a*) is a facsimile of the certificate of registry used by the Ayrshire Breeders' Association and will serve to show how the facts pertaining to registration are set forth. In addition to the certificate of registry there is sometimes printed on the same sheet a blank for records of transfer, as shown in the illustration. In (*b*) is shown the reverse side of the blank. When the breeder disposes of a registered animal it is necessary for him to return to the secretary of the association the certificate of registry, together with another blank properly filled out, requesting that the transfer be made on the records of the association. An application for transfer such as is used by the Holstein-Friesian Association of America is shown in Fig. 3.

20. The blanks shown herewith were chosen at random and are merely intended to show the general plan on which

the registration of pure-bred dairy cattle is conducted. It is impracticable to show examples of similar blanks used by the various dairy cattle associations, but the general form is


H. R. Number 18003
Date of Entry Oct 14, 1904
Volume 15 Part 62

EACH ANIMAL OFFERED FOR ENTRY MUST BE DESCRIBED IN THIS FORM.

Name Lady Putnam's Lilla
Sex Female When dropped May 14, 1902
H. R. Name and No. of Sire Milo of the Elms 7179
H. R. Name and No. of Dam Lady Putnam 15969
By whom bred* (Name and Address) Mrs. Grace H. C. Cammann Greenwich, Conn.
Names and addresses of all the owners, since dropped Mrs. Grace Cammann
If imported, name of importer .... Port of entry ....
Date of landing .... Name of ship ....
If a Cow, date of service .... By whom bred ....
H. R. Name and No. of Bull ....
Color and distinguishing marks, as sketched on the reverse page Dark fawn and white

(* The breeder is the owner of Dam at time of service.) I hereby certify to the above statements and offer this animal for entry in The Herd Register for Guernsey Cattle, in accord with the regulations imposed by the Constitution and By-Laws of The American Guernsey Cattle Club.

Date Oct. 11, 1904 Sign here Mrs. Grace H. C. Cammann.

Application for Entry in The Herd Register of The American Guernsey Cattle Club.

THE AMERICAN GUERNSEY CATTLE CLUB,
WM. H. CALDWELL, Sec'y and Treas., Peterboro, N. H.

(a)

Sketch each side of the animal and the face.

L. F., Light Fawn
F., Fawn
D. F., Dark Fawn
R. F., Red Fawn
W., White

I hereby certify that the above is a representation of the markings of the animal I offer for entry in the books of THE AMERICAN GUERNSEY CATTLE CLUB, the pedigree of which is given on the other side of this application.

Signature of applicant Mrs. Grace H. C. Cammann

Date ....

This space to be filled at office.

(b)

FIG. 1

the same. In addition to those shown, a number of other blanks are commonly used by breeders' associations for collecting and recording facts pertaining to individuals and

No. 9586746 **The Ayrshire Breeders' Association**

CERTIFICATE OF REGISTRY

The Cow Named Philanthropy Lebank

Bred by John Goodwin Smith, East Rockaway, Pa.

Owned by Henry Gordon Porter, Mineola, Wis.

Born September 4, 1902 Color White and Red

Sire Joe Burplay 136478

Dam Mimie Lebank 6574836

Has been accepted for registry in the MMVXXIV volume of the Ayrshire Record, under the rules of the Association, and will be numbered as above.

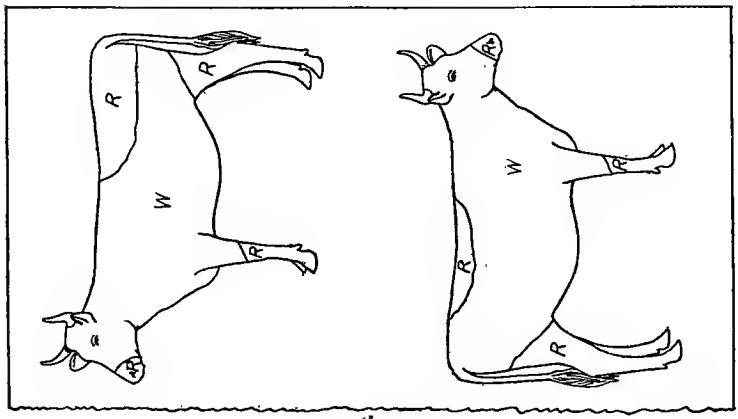
June 12, 1904 *Signature* Secretary, Brandon, Vt.

This Animal has been duly transferred in the Ayrshire Record as follows:

TRANSFER RECORD

Date	From	To	No Record valid unless signed by the Secretary
September 8, '10	Henry Gordon Porter, Mineola, Wis.	Frank Cotton Hayes, Mineola, Wis.	
April 6, 1911	Frank Cotton Hayes, Mineola, Wis.	Harry Harlow Beach, Somerville, Wis.	

(a)

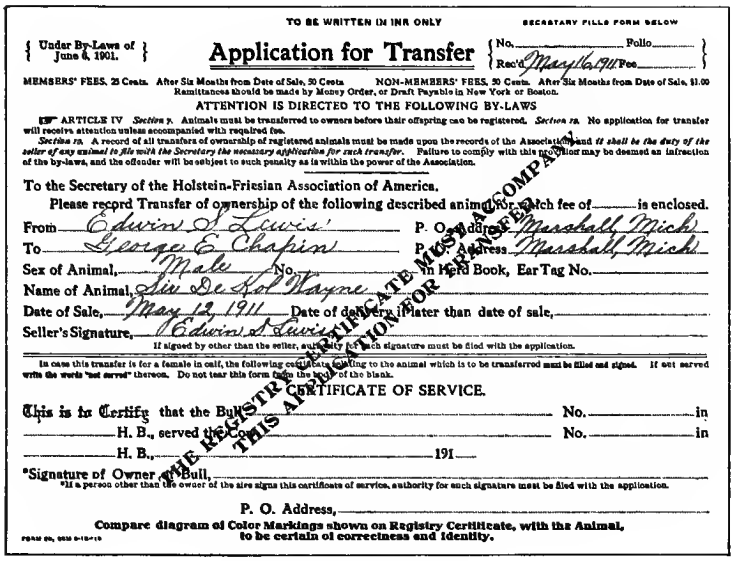


(b)

FIG. 2

the breed, but a detailed description of them is unnecessary, since they are largely self-explanatory.

As a rule, a dairyman who is raising pure-bred cattle will find it to his advantage to become a member of the association that is looking after the interests of the particular breed he is raising. Most breeders' associations charge a lower fee for registering animals for members than for non-members. The saving effected in this way is considerable if many animals are registered, and there are other advantages to be derived



TO BE WRITTEN IN INK ONLY — SECRETARY FILLS FORM BELOW

{ Under By-Laws of June 6, 1901. }

Application for Transfer

{ No. ..... Folio ..... Rec'd May 16, 1911 Fee ..... }

MEMBERS' FEES, 25 Cents. After Six Months from Date of Sale, 50 Cents. NON-MEMBERS' FEES, 50 Cents. After Six Months from Date of Sale, $1.00

Remittances should be made by Money Order, or Draft Payable in New York or Boston.

ATTENTION IS DIRECTED TO THE FOLLOWING BY-LAWS

☞ ARTICLE IV *Section 7.* Animals must be transferred to owners before their offspring can be registered. *Section 10.* No application for transfer will receive attention unless accompanied with required fee.

Section 10. A record of all transfers of ownership of registered animals must be made upon the records of the Association, and *it shall be the duty of the seller of any animal to file with the Secretary the necessary application for such transfer.* Failure to comply with this provision may be deemed an infraction of the by-laws, and the offender will be subject to such penalty as is within the power of the Association.

To the Secretary of the Holstein-Friesian Association of America.

Please record Transfer of ownership of the following described animal for which fee of ..... is enclosed.

From Edwin S. Lewis P. O. Address Marshall, Mich.

To George E. Chapin P. O. Address Marshall, Mich.

Sex of Animal, Male No. ..... in Herd Book, Ear Tag No. .....

Name of Animal, Sir De Kol Wayne

Date of Sale, May 12, 1911 Date of delivery if later than date of sale, ...

Seller's Signature, Edwin S. Lewis

If signed by other than the seller, authority for such signature must be filed with the application.

In case this transfer is for a female in calf, the following certificate relating to the animal which is to be transferred must be filled and signed. If not served write the words "not served" thereon. Do not tear this form from the body of the blank.

CERTIFICATE OF SERVICE.

This is to Certify that the Bull ..... No. ..... in ..... H. B., served the Cow ..... No. ..... in ..... H. B., ... 191...

*Signature of Owner of Bull, ...

*If a person other than the owner of the sire signs this certificate of service, authority for such signature must be filed with the application.

P. O. Address, ...

Compare diagram of Color Markings shown on Registry Certificate, with the Animal, to be certain of correctness and identity.

THE REGISTRY CERTIFICATE MUST ACCOMPANY THIS APPLICATION FOR TRANSFER

FIG. 3

from keeping in touch with other breeders who are handling the same kind of cattle.

21. Breeders' associations usually endeavor to encourage early registration of animals by making the fee considerably smaller for animals under a certain age than for older animals, and the difference is usually sufficient to make it advisable to register calves within the time limit. Some breeders do not register young calves, because of the loss of the fee in case

the calf dies before it reaches the age of usefulness and there are many breeders who make it a rule not to register bulls until they are sold. Both of the practices are, however, doubtful economy, not only because registration of young animals costs less, as explained, but also because early registration is favorable to systematic and businesslike management of the herd.

Dairy cattle associations usually provide for advanced registry of superior animals in the manner described in *Breeds of Dairy Cattle*. Advanced registry is regarded as evidence of conspicuous merit, and animals so recorded or eligible to it command a higher price than ordinary individuals. A dairyman will, therefore, find it advisable to take advantage of this feature if any of his animals will meet the requirements laid down by the association governing advanced registry.

MILK
(PART 1)

SECRETION AND COMPOSITION OF MILK

SECRETION OF MILK

1. Milk is the whitish, opaque liquid secreted by the mammary glands of female mammals for the nourishment of their young. Under natural conditions the secretion of milk ceases as soon as the young no longer need it; under artificial conditions, as in the case of dairy cattle, the period of lactation has been lengthened until it covers a much longer time than for the needs of the calf. The long period of milk flow in dairy cattle is the result of many years of selection and breeding.

The word milk as it is commonly used refers to the milk of the cow, as that produced by this animal is of the greatest commercial importance. The milk from the females of the sheep, goat, ass, and horse, also, is sometimes used as human food. Unless otherwise specified, however, the term milk, when used in this Section, refers to the milk of the cow.

The milk from which the butter fat has been removed is known as *skim milk;* that from which the fat has not been removed, as *whole milk;* that from a number of animals or of several herds, as *mixed milk.*

2. Organs of Milk Secretion.—Female mammals have two mammary glands and each gland may be divided into two or more lobes, each having a separate opening. In the cow,

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ENTERED AT STATIONERS' HALL, LONDON

there are regularly four of these openings, but in occasional cases, six; in the mare and ewe, two; in the sow, from ten to fourteen. In the cow, the mammary glands are on the under surface of the body between the hind legs. Each of the two glands is made up of two parts, and each part is known as a quarter. The four quarters taken as a whole is termed the *udder*, and the four fleshy, pendulous parts through which the milk is removed, are the *teats*.

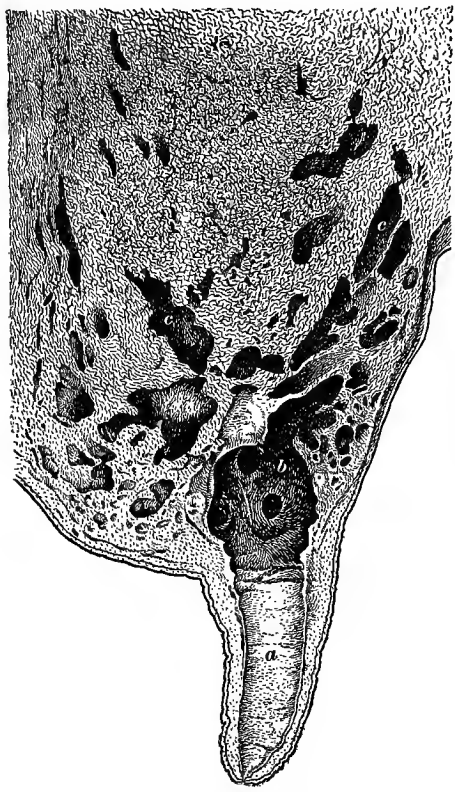


FIG. 1

3. Structure of a Cow's Udder. — In Fig. 1 is shown a sectional view of one-quarter of a cow's udder. The part marked *a* is the teat. Extending through the teat is a canal through which the milk passes. At the upper and the lower end of the canal are muscles that open and close the openings. Above the teat is a cavity *b*, known as the *milk cistern*, which has a capacity of about one-half pint and from which the milk is drawn through the teat. Canals *c*, known as *milk ducts*, extend in all directions through the fleshy portion of the udder, and branch and rebranch to form smaller and smaller canals, each of which finally ends in a group of small sacklike bodies that are termed *follicles*. In these follicles the milk is secreted. They are small cavities about $\frac{1}{30}$ inch

in diameter, and are arranged in groups of from three to five with a common outlet into a branching duct. The system of milk ducts and follicles has been compared to a bunch of grapes in which the grapes represent the follicles and the stems the milk ducts.

The ducts from each cistern form practically a distinct system, although there is a slight connection between the two quarters on the same side near the top of the quarters, but none between the quarters on opposite sides. A small part of the milk from a hind quarter of the udder can, therefore, be drawn through the front teat on the same side, and vice versa, but milk from the quarters on one side cannot be drawn through the teats on the other side.

4. Time of Milk Secretion.—The milk is secreted in large part during the process of milking. That this is the case is shown by the fact that an animal may give, at a single milking, a weight of milk greater than the weight of the udder itself. Some milk is secreted previous to the milking, however, as is shown by the distention of the udder before milking is commenced.

COMPOSITION OF MILK

MILK CONSTITUENTS

5. Milk consists of water, butter fat, protein, sugar, and ash. The last four of these constituents are known as the solids of milk, and, when considered collectively in an analysis, are termed the total solids. The proportion of the various constituents varies at different stages of the lactation period. The first milk secreted after a calf is born is a thick, yellowish liquid having a strong odor and a bitter taste, and is known as *colostrum*. In composition, colostrum from different cows varies considerably. The following, however, is a general average:

	Per Cent.
Water	72.39
Fat	1.30
Sugar	1.52
Protein	23.70
Ash	1.09
	100.00

Colostrum is helpful to the new-born calf, but it is undesirable as human food, and, therefore, should not be made a part of the regular milk supply. A change in the composition of milk takes place rapidly, and in from five to seven days after the calf is born the milk becomes suitable for use as human food. The average composition of milk after the change is about as follows:

	Per Cent.
Water	87.40
Fat	3.75
Protein	3.15
Sugar	5.00
Ash	.70
	100.00

Milk from different cows varies considerably in composition from this average. Probably the greatest difference is in the percentage of fat. Cows are known that give milk in which there is as much as 8 per cent. of fat, and there are others that give milk in which there is less than 3 per cent. of fat.

Near the end of the lactation period, milk undergoes another change in composition. The percentage of fat increases until in many instances the fat content is twice as much as before the change, the fat globules become much smaller, and the solids other than fat increase somewhat in total percentage. The taste of the milk also may change, becoming bitter and salty, and when in this condition milk is not suitable for use as human food. The quantity of milk given by an animal decreases at this time until often the yield per cow is only 2

or 3 quarts a day. On account of the changes that occur during the last part of the lactation period, some dealers will not purchase the milk. They guard against receiving it by refusing to purchase milk obtained from cows that give less than 3 quarts a day.

6. In Table I is given the average composition of milk from the cow, nanny-goat, ewe, and mare, for the purpose of showing the difference in the percentages of the different constituents in the milk of these animals.

It can be seen from the table that milk from sheep and from goats is richer in both fat and protein, and that the milk from a mare is much poorer in fat and protein than is cow's milk. It can be seen, also, that the milk of the mare is the richest in sugar, and that the milk from both the goat and the ewe is less watery than that from the cow or from the mare.

TABLE I

COMPOSITION OF MILK OF DIFFERENT SPECIES OF ANIMALS

Species of Animal	Water Per Cent.	Fat Per Cent.	Protein Per Cent.	Sugar Per Cent.	Ash Per Cent.
Cow	87.40	3.75	3.15	5.00	.70
Nanny goat	85.71	4.78	4.29	4.46	.76
Ewe	80.82	6.86	6.52	4.91	.89
Mare	90.78	1.21	1.99	5.67	.35

7. Butter Fat.—The **butter fat** of milk, which is also known as *milk fat*, is made up of small globules, the number in a single drop of milk varing from 30,000,000 to 100,000,000. The globules are arranged both singly and in aggregations. The fat is the lightest part of milk, and if milk is allowed to stand quietly for a time most of the globules rise to the surface. Some of the smallest globules, however, are not able to overcome the resistance encountered in passing upwards through the milk, and hence do not rise to the surface. The globules in the milk of cows of different breeds vary somewhat in size.

For example, the globules in the milk of Jersey and Guernsey animals are larger than those in the milk of Shorthorn or Holstein animals. Examinations show that if the average size of the individual globules in the milk of Shorthorns is represented by 1, the average size of those in Guernsey milk is represented by 1.25, and of those in Jersey milk by 1.6.

Cream is the part of milk into which a large part of the fat is gathered. The separation of cream from the other part of milk is known as the *creaming of milk*. Gravity creaming, or separation, can be accomplished by allowing the milk to stand quietly for a time, and then removing the upper layers, in which the fat has accumulated. Cream can be separated also by means of machines known as centrifugal separators. The principle on which these machines are based is that as cream is lighter than the remaining part of the milk, centrifugal force can be used in the separation of the two.

8. Protein.—Two of the substances of milk, **casein** and **albumin**, belong to the class of compounds known as protein. Casein forms a large part of the curd obtained when milk is allowed to sour or when milk is curdled by the addition of *rennet*, a material employed in the manufacture of cheese. Casein gives to milk much of its opacity. The casein appears to be in solution, since it does not settle out when milk is allowed to stand. It can, however, be filtered out by the use of very fine filters.

If whole milk is curdled, the fat globules are enclosed in the curd. The removal of the curd leaves a yellowish or greenish clear liquid, the whey, which contains the constituents of the milk that are in solution. One of these is albumin, a substance that coagulates on heating and that, in appearance, is much like the white of an egg. The quantity of albumin in milk, except in colostrum, is small, and is not sufficient to cause the milk to become semisolid on heating. In colostrum, however, there is such a large percentage of albumin that this first milk will coagulate if heated.

9. Milk Sugar.—The sugar found in milk is known as *lactose*. It is much less sweet and less soluble than cane

sugar and is obtained by condensing the milk and allowing the sugar to crystallize. It is used for medicinal purposes and for the modification of milk for children.

10. Ash.—Some of the compounds that form the ash of milk are in solution, and hence are found in the whey; others are insoluble and are removed in the curd. The ash constituents are an important part of the milk; without them it would not be a perfect food for young animals.

FACTORS INFLUENCING MILK COMPOSITION

11. Influence of Breed on Milk Composition.—The milk of the different breeds of cattle differs materially in composition, especially in the quantity of butter fat. In Table II is given the average composition of the milk from representative animals of four important dairy breeds, and of the milking family of the Shorthorn breed.

TABLE II

COMPOSITION OF MILK OF COWS OF DIFFERENT BREEDS

Breed	Water Per Cent.	Fat Per Cent.	Protein Per Cent.	Sugar Per Cent.	Ash Per Cent.
Jersey	85.66	4.78	3.96	4.85	0.75
Guernsey	85.52	5.02	3.92	4.80	0.74
Ayrshire	87.30	3.68	3.48	4.84	0.70
Holstein	87.88	3.51	3.28	4.69	0.64
Shorthorn	87.55	3.65	3.27	4.80	0.73

It can be seen from the table that the milk of the cows of the Jersey and Guernsey breeds is the highest in fat; that of the Ayrshire and Shorthorn cows is next; and that the milk of the Holstein is the lowest. In protein, Holstein and Shorthorn milk are lowest. In the percentage of sugar, little difference is to be noted. In total solids, the milk of Jersey and Guernsey cattle is higher than that of any of the other breeds.

12. Influence of Time of Milking on Milk Composition. The composition of milk is influenced somewhat by the length of time that elapses between successive milkings. If the length of time between milkings is always the same, there will be practically no variation in composition, but if a longer time elapses between two successive milkings than between the next two, a variation can be noticed. In general, the milk that is drawn after the shortest period of time is richest in butter fat. To guard against having a difference in composition of the milk from successive milkings, a dairyman should arrange his barn work so that 12 hours elapses between the two milkings each day. In practice, however, it often occurs that more time elapses between the evening and the morning milkings than between the morning and evening milkings, and as a result dairymen often find that the evening milk is richer than that drawn in the morning.

13. Influence of Stage of Milking on Milk Composition. There is a variation in the composition of milk drawn at different stages of the same milking. The first milk drawn

TABLE III

COMPOSITION OF MILK AT DIFFERENT STAGES OF A SINGLE MILKING

Stage	Fat Per Cent.	Solids Not Fat Per Cent.
First Stage	1.70	8.77
Second Stage	1.76	8.99
Third Stage	2.10	8.75
Fourth Stage	2.54	8.69
Fifth Stage	3.14	8.49
Sixth Stage	4.08	8.59

is very poor in fat; the last milk, the *strippings*, is high in fat. Table III shows the composition of milk from a single animal at each of six consecutive stages of the same milking.

It can be seen from the table that the difference in composition is largely due to an increase in the percentage of fat. One explanation offered by dairymen why the fat content differs during different stages of a milking is that the milk that has stood in the lower part of the udder has lost its fat on account of reabsorption, but this theory has not been definitely proved.

14. Influence of Feed on Milk Composition.—It is believed by many that the feed of an animal has much to do with the composition of the milk, and that the percentage of fat in milk can be increased by feeding a ration rich in fat. Experiments prove, however, that such is not the case. A change from green to dry feed may cause a temporary change in the composition of the milk, but such a change does not persist for more than a few days.

The feed may affect the color of the milk to a slight extent; fresh grass heightens the yellow color of the fat and hence of the milk, and the feeding of carrots also tends to make milk more yellow. The feed may often affect the taste and odor of the milk. The feeding of beet leaves, turnips, and malt sprouts is said to cause an unnatural taste and odor in the milk, and cabbage, rape, garlic, wild turnip, ragweed, and many other weeds, which may be consumed by the animals in pastures, sometimes injure the flavor of the milk. Even the turning of cattle into clover or young rye may impart, at least temporarily, an abnormal taste to the milk. These flavors do not injure the wholesomeness of the milk, but they render it less appetizing and injure it for butter and cheese making. Silage, especially very sour silage, affects the taste of the milk to a slight extent, but does not make it unappetitizing. Many people prefer the milk from silage-fed cows to that from cows on dry feed, and it is known that the flavor is not usually so marked as that imparted to milk by fresh grass when cattle are first turned into the pastures. Some of the milk-condensing companies will not allow the feeding of silage to herds furnishing them milk; others advocate its use.

Some drugs, when given to milch cows, may affect not only the wholesomeness but also the healthfulness of the milk. Milk from cows that are receiving medicine should, therefore, never be used for human food. This is especially true when the milk of a single animal, or of a few animals, is used as food for children.

CONTAMINATION AND FERMENTATION OF MILK

BACTERIA IN MILK

ACTION OF BACTERIA IN MILK

15. Soon after milk is drawn it begins to undergo changes, the most apparent one of which is that of becoming sour, or acid. This and many of the other changes are caused by bacteria. Many kinds of bacteria are nearly always present in milk, but in varying numbers. It is known, however, that milk produced under cleanly conditions is much freer from bacteria than that produced under unclean conditions. Cleanliness, therefore, is an important consideration in milk production. Certain kinds of bacteria are responsible for diseases of mankind, and many of these disease-producing bacteria grow luxuriantly in milk and are often found there in large numbers; the best way to exclude them is by producing and caring for the milk in the most sanitary manner possible.

Bacteria thrive best where food is abundant, where the temperature is favorable for their growth, and where moisture is present. These three conditions are found in the soil and in the alimentary tract of animals; therefore, any material from these sources—mud, dirt, or manure, for example—that gets into a quantity of milk carries with it a number of bacteria. In the milk they find conditions favorable for growth—food is plentiful; the temperature, especially if the milk be warm, is favorable; and moisture is present. As a

result, they multiply rapidly and in a comparatively short time the milk will contain so many bacteria that it is likely to be unfit for use.

No other food is so exposed to contamination by mud, dust, and manure, as is milk. If a solid food becomes dirty it can be washed, but when bacteria have once been introduced into milk, the harm cannot be remedied, for milk cannot be cleaned like a solid. Insoluble particles of dirt and manure can be removed by straining milk through a fine-meshed cloth, but many of the bacteria that are on the particles will be washed off and will pass through the cloth. Thus, if milk is to keep well and be an appetizing, healthful human food, it must be produced under such conditions that bacteria do not enter it in large numbers.

SOURCES OF BACTERIA IN MILK

16. Bacteria in Udders of Cows.—The udders of cows, as they are exposed constantly to dirt and manure, are exposed also to bacteria. There is usually a small quantity of moisture on the ends of the teats, and this, together with the body warmth and food that are present, make conditions favorable for bacterial growth. The bacteria enter the teat canal and work their way to the milk cistern, milk ducts, and even into the secreting tissue of the udder. However, only certain kinds of bacteria are able to grow in the udder, just as certain kinds of higher forms of plants grow in a certain environment of temperature, moisture, food, etc. These bacteria do not develop as rapidly as might be expected; something seems to hold them in check. The nature of most kinds of bacteria found in the udder is such that they have but little or no effect on the keeping quality of the milk or on its taste and odor.

More bacteria are found in the teats, milk cisterns, and large milk ducts than in the other parts of the udder, and, as the first milk drawn comes directly from the milk cisterns, the number of bacteria in a milking can be lessened by rejecting the first five or six streams from each teat. As the per-

centage of fat in the first milk drawn is small, no great loss is incurred by rejecting this milk. However, care should be taken to prevent it from getting on the floor of the stable, as its presence causes a bad odor, especially during the warm seasons of the year.

17. Bacteria From Coat of Cow.—During the milking of a cow, considerable dust and hair are dislodged from the udder and flank of the animal by the motions of the milker, and

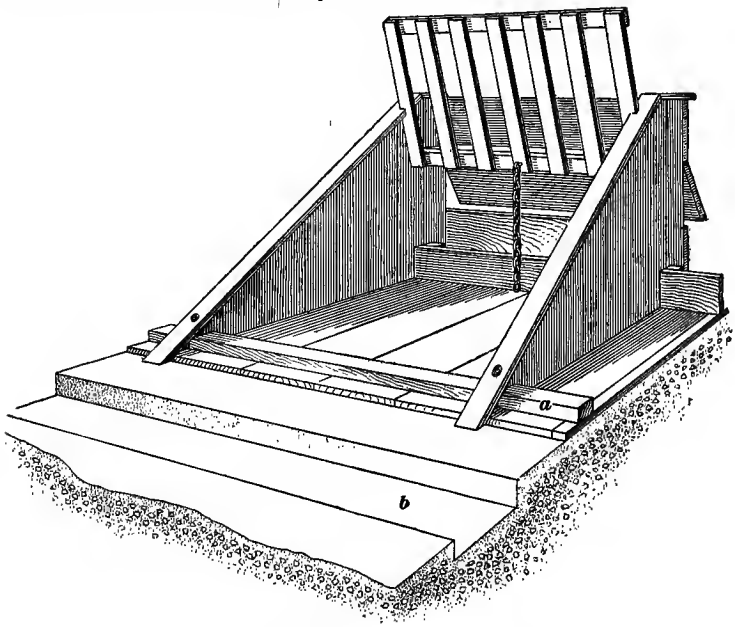


FIG. 2

a large part of this material may find its way into the milk pail. On account of this hair and dust being covered with bacteria, many germs gain entrance to the milk in this way. Fewer bacteria will get into milk from this source if the coat of the animal is clean than if it is dirty, but too often the udder and teats are covered with mud and manure, and under such conditions it is impossible to milk the animal without getting a large quantity of germ-laden material into the milk.

It should be the aim of dairymen to keep the cows clean. They should not have access to mud holes, etc., and the barnyard, if one is in use on the farm, should be well drained and covered with gravel, crushed stone, or concrete to prevent it from becoming muddy. In addition, manure should be excluded from the yard in which the animals are kept.

18. The stalls in a dairy barn should be arranged so that it is impossible for the cows to lie in the manure back of the stall. There are on the market several stalls, or cattle ties, that have been designed to accomplish this end. Usually it

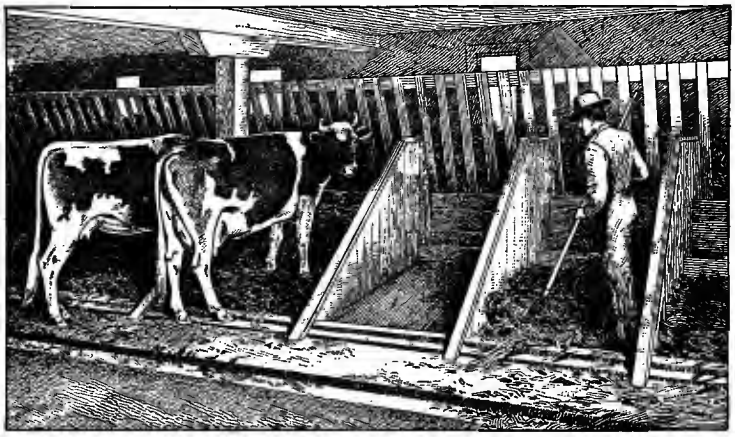


FIG. 3

is done by arranging some contrivance that will force the animal to the back of the stall when she is standing and to the front part when she is lying down. In Fig. 2 is illustrated what is known as the *Model stall.* This is an unpatented equipment and hence can be used without restrictions. The part that has been devised for keeping the animal out of contact with her manure is a $2'' \times 3''$ plank a, which is placed as shown in the illustration. This piece should be arranged so that it is just in front of the hind feet of the animal as she stands in the stall. On lying down, she will soon learn that in order to gain a comfortable position she must crowd

forwards to avoid the strip, and when thus crowded forwards she will be out of contact with any manure that is in the gutter *b* or on the ledge in front of it. The plank serves also to keep the bedding from being pushed back into the manure gutter, and the bedding is, therefore, kept much cleaner than in a stall having no such provision as the plank. Fig. 3 is made from a photograph, and shows the appearance of cows kept in Model stalls. No cleaning had been done on the animals at the time the photograph was made, and no mud or caked manure was visible on their bodies.

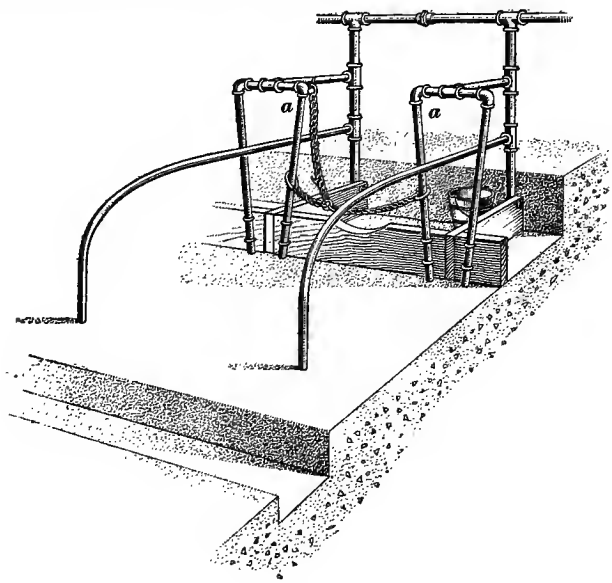


FIG. 4

19. Another type of stall, known as the New Ideal stall, is shown in Fig. 4. Stalls of this kind are used in the dairy barn at the Purdue University Experiment Station, at Lafayette, Ind., where they have given excellent satisfaction. The stall, with the exception of the manger and floor, is made of gas pipes. The guides *a* on which the chain tie slides up and down are nearer to each other at the top than at the bottom, and when the cow lies down in the stall the

arrangement tightens the chain and thus draws her forward out of the manure.

In constructing stables for dairy cows, farmers are likely to pay more attention to arrangements for convenience in feeding, cleaning the stable, etc. than to devices for keeping the cows clean. The latter should, however, receive much attention, as the quality of the milk that is produced in the stable will depend largely on the cleanliness of the cows.

The bedding used for dairy cows should be abundant and free from dust. Rotten and moldy straw should not be used, as it is likely to get on the coats of the animals and thus become a source from which the milk can be contaminated. Clean, bright straw, shredded or finely-cut corn stalks, and shavings are good bedding materials for dairy barns.

One of the most important considerations in the production of clean milk is to prevent the cows from getting dirty. When all that can be done in this direction has been accomplished, a further step is the cleaning of the cows just before they are milked. The cleaning, or grooming, of cattle is an operation too often overlooked. Careful grooming removes much of the loose dirt and hair from the coats of the animals and thus aids in producing milk containing comparatively few bacteria. Wiping the udders and flanks with a clean, damp cloth just previous to milking also is a good practice, as it removes the loose dirt and hair and dampens the hair of the coats so that less dust will fall than from dry coats. Washing the udders with water and wiping them with a clean towel still further diminishes the quantity of dirt and hair that can get into the milk.

20. Vacuum cleaners similar to those used for cleaning houses, offices, etc. are sometimes used in dairy barns for the grooming of cattle. An advantage of a vacuum cleaner for this purpose is that the dust, loose hair, and dandruff from the coats of the cows are drawn off into a dust collector, and, hence, none of the material escapes into the stable. The disadvantage of the cleaners is their high cost, a complete outfit costing in the neighborhood of $130. As a rule, they

are used in barns where a vacuum type of milking machine has been installed, as the vacuum pump, pipe line, engine, or other power used for the milking machines are suitable also for a cleaning outfit. Where a vacuum type of milking machine is in use, the cost of added equipment for the installation of the cleaner is about $27. Vacuum cleaners are usually sold by the firms that manufacture vacuum milking machines.

In Fig. 5 is illustrated a vacuum cleaning outfit, with the exception of the vacuum pump and the power for operating

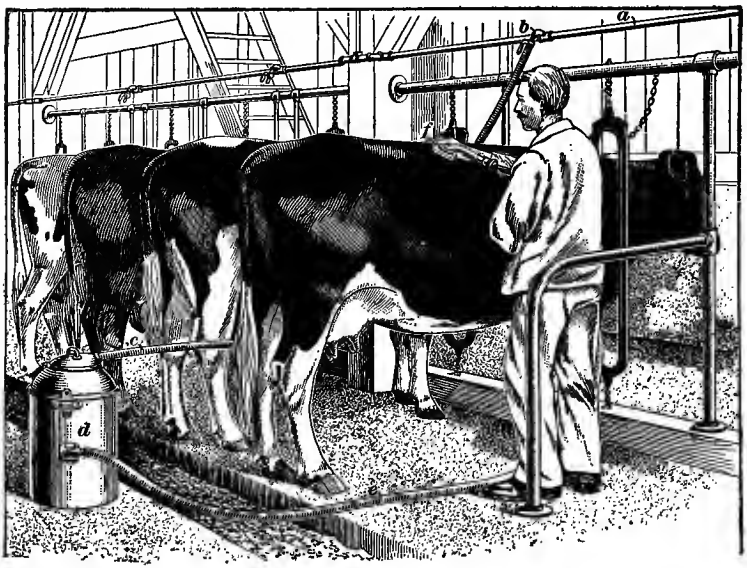


FIG. 5

it. At *a* is shown the pipe line in which the vacuum is created; at *b*, a stanchion cock for turning the suction on or off; at *c*, the hose from the pipe line to the dust collector *d*; and at *e*, the hose from the collector to the cleaning tool *f*.

When an animal is to be cleaned, the stanchion cock is opened and the cleaning tool is pushed back and forth over the coat as shown in the illustration. The suction draws all loose hair, dust, dandruff, etc. through the hose *e* into the dust collector *d*, where it is retained by screens of cloth that

prevent it from passing through the hose *c* into the pipe line *a*. The dust collector is light in weight, and thus is easily moved from place to place.

21. After the animals have been cleaned, it is essential that they be prevented from again becoming dirty before being milked. This can be done by keeping them standing. A chain across the stanchions, as shown in Fig. 6, at *a*, that will be just below the animal's neck is a device sometimes employed for this purpose. The chain, of course, should be unhooked as shown at *b*, after the cow has been milked.

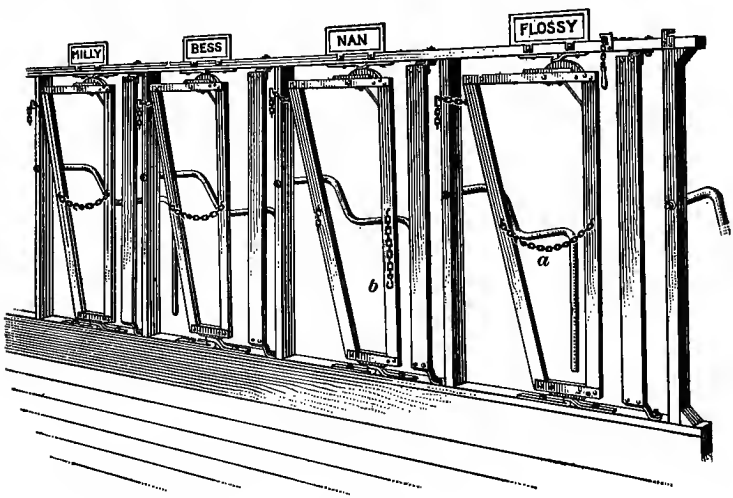


FIG. 6

The clipping of the hair from the hind legs, flanks, and udders of dairy cows is a good practice, as it will be found that the animals will keep cleaner and can be more easily cleaned in case they become soiled. Hand clippers are often used for this purpose. Small clipping machines operated by hand power, like the one illustrated in Fig. 7, are used on many dairy farms.

22. Bacteria From Dust of Stable.—Dust from fine particles of fodder, dirt, and manure is very objectionable in a stable on account of the bacteria it carries. The dust,

during the milking time, falls into the milk pail, and thus bacteria are added to the milk. Effort should be made, therefore, to have a minimum quantity of dust in a stable while the milking is being done. The feeding of dry fodder, the grooming of the cattle, and the sweeping of the stable should all be done at least one hour before or delayed until after the animals are milked. The ceiling of the stable should be tight to prevent dust from falling from the lofts above.

23. Bacteria Prevalent in Dark Stables.—Plenty of windows should be provided in a stable where dairy cows are kept, as bacteria do not thrive in sunlight and abundant light is necessary for the health of the animals; the presence

FIG. 7

of light also makes evident dirt that might otherwise be unnoticed. At least 4 square feet of window space should be provided for each animal, as less than this amount is likely to make the stable so dark that bacteria and all their evils will abound. Too great a window space is undesirable, however, as it is then difficult to keep the stable warm in winter. This is especially true if the windows are on the north side of the building.

24. Excluding Bacteria by Use of Sanitary Milk Pail. Much dirt, manure, hair, etc., can be kept out of milk by making use of the right kind of milk pail. Larger quantities

of dust, hair, dandruff, etc. will fall into an ordinary large-topped milk pail than into a pail the top of which is protected by a hood with a small opening, as in the so-called *sanitary*, or *small-topped, pails* illustrated in Fig. 8. It has been shown by experiment that such pails are exceedingly efficient in excluding dirt and bacteria from milk. Under fair barn

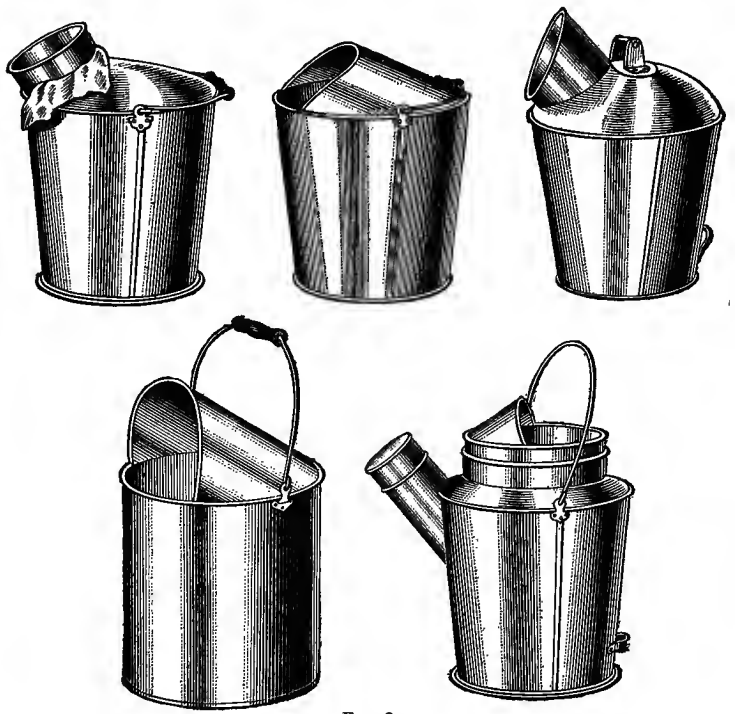


FIG. 8

conditions, it was found that milk drawn into such pails contained but one-twentieth as many bacteria as milk drawn under similar conditions into open pails.

25. Cleanliness of Utensils—All utensils used about a dairy should be constructed so that they can be easily cleaned, and every precaution should be exercised to keep them clean. Milk pails and milk cans should be smooth on the inside, and

there should be no open seams or sharp corners, and all parts should be exposed so that they can be reached by a cloth or brush while being cleaned. Fig. 9 illustrates the right and the wrong kinds of seams and corners in milk utensils. In (*a*) is shown the outline of a milk pail with a sharp angle between the sides and the bottom. Depressions formed in this way are very difficult to clean and the dirt that is sure to be left in them does not dry out between the periods of use; as a result, the bacteria multiply rapidly and find their way into the milk. The proper construction of seams in pails or cans is shown in (*b*). This can be provided even in an inexpensive vessel by flushing the joint depressions with solder. In (*c*) is shown a cross-section of the kind of seam that is too often found in milk pails. The depression *a* affords a place where bacteria are sure to collect. Open joints of this kind should be filled with solder, as shown in (*d*), to make them safe for use in milk pails.

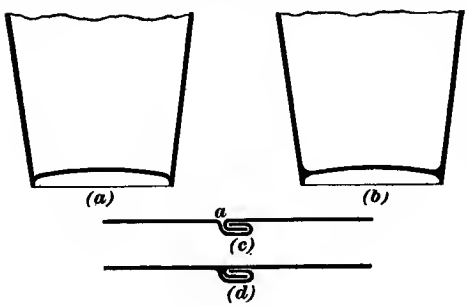


FIG. 9

Roughness of the surface, such as is caused by spots of rust, is undesirable in milk pails and like utensils on account of the likelihood of bacteria collecting on them. A bright, clean surface is, therefore, best in all utensils used about a dairy.

If possible, the utensils should not be allowed to become dry before being washed, as dried milk, especially skim milk, is very difficult to remove, owing to the fact that it forms a glue that does not easily soften in water. The utensils should be rinsed in cold or lukewarm water, then washed in hot water to which a small quantity of alkali cleansing powder has been added. Powder is preferable to soap, as it is more efficient in removing the dried milk and can be rinsed from the surface more easily. Perfumed powder should never be used for this purpose. The utensils, after having

been washed with hot water and washing powder, should again be thoroughly washed and sterilized with boiling water or steam, a large enough quantity of either being used to insure a perfect cleansing and sterilization. It is not necessary that the utensils be wiped, for they will dry quickly if inverted and left to drain.

26. Milk cans used by farmers for delivering milk from farms to creameries or cheese factories are often the source of milk contamination. From the skim milk or the whey returned to the farms in cans, serious contamination often results. These products are often sour and contain undesirable kinds of bacteria; hence, to guard against infection, the cans should be thoroughly washed and sterilized before being used for whole milk again. Some progressive milk dealers wash and sterilize the cans before they are returned to the farms, as they find that at the factory where steam is available the process can generally be carried out more efficiently than on most farms.

27. When bottles are used for milk, special care should be taken in cleaning them. Brushes for cleaning the bottles can be purchased from dealers in dairy supplies, and dairymen will find it to their advantage to procure and use brushes for this work. If only a few bottles are to be washed, a hand brush will generally answer the purpose, but if a large number must be cleaned daily a brush that is whirled by tread or steam power is more satisfactory. After the bottles have been thoroughly washed, they should be placed in boiling water for a few minutes and then placed in an inverted position on draining boards. These draining boards should have holes in them large enough to allow each bottle to drop one-third of its length through the board. The reason for the use of boiling water in washing bottles is that all bacterial life that may be in the bottles is likely to be killed by the high temperature of the water.

Such complicated dairy utensils as milking machines and cream separators must be cleaned with great care. The rubber teat cups and the rubber tubes that are used with

milking machines cannot be washed with water and cleansing powder in a manner to prevent bacterial growth on their inner surface, and for this reason many people have been led to believe that good milk could not be produced with a milking machine. If, however, these parts are immersed in a ½-per-cent. solution of formaldehyde during the time they are not in use, care being taken that the tubes are completely filled with the liquid, no difficulty will be experienced in keeping them free from bacterial infections. After the parts are removed from the formaldehyde solution they should be washed in water before being used again. The metal parts can be kept in good condition by the use of boiling water and cleansing powder.

28. Cream separators should have the bowl removed after each period of use and the parts should be carefully cleaned, for it is impossible to remove the slime that collects simply by passing water through the machine. This slime, if not removed, furnishes food for bacteria, and the next time the machine is used the milk and cream are likely to become contaminated.

The cloth strainers that are used for removing solid particles from milk are not easily kept free from bacteria. Enough material to furnish abundant food for bacteria will remain on them even after the most careful washing. To minimize the number of bacteria left on a cloth, it should be thoroughly washed and sterilized in boiling water and then hung where it will quickly dry. If allowed to remain damp, any bacteria that may remain on the cloth will have a chance to grow and will contaminate the milk when the strainer is next used.

29. Milker as Source of Bacterial Infection.—The milker is often a source from which bacteria get into milk. If the clothes worn during the milking are dusty and dirty, a larger number of bacteria are sure to get into the milk than if clean jumpers and overalls are worn. The hands should be clean, also, as some milk is likely to come in contact with them; the milking should be done with the whole hand and not by stripping the teats with the thumb and finger, for the latter

method rubs off much dirt from the teats. The hands should be kept dry, for if moistened with milk or water a small quantity of the liquid, which is sure to contain bacteria, is very likely to drop into the pail.

CONTROL OF BACTERIA IN MILK

30. In the commercial handling of milk, it is necessary to employ means for controlling the number of bacteria either by the exercise of cleanliness in the production of the milk, the prevention of the growth or the destruction of any bacteria contained in the milk, or by a combination of these methods.

31. Cleanliness as a Means of Control.—One of the most efficient ways of controlling the number of bacteria in milk is to exercise cleanliness at every step in the production and handling. Milk that contains only the bacteria coming from the udder will not sour for days, but that containing large quantities of dirt will often be unfit for use in a few hours. Prevention of contamination is one of the most important ways of improving the keeping quality of milk.

32. Clarification of Milk.—When milk containing sediment is passed through a centrifugal separator, the particles collect as slime on the wall of the separator bowl and are thus removed from the milk. The process of removing solids in this manner is known as **clarification.** It is much more efficient for the removal of dirt, etc. than any method of straining, and is often employed by city milk dealers to rid milk in bottles from sediment. Clarification does not, however, improve the keeping quality of milk as much as might be imagined, for only a small number of bacteria are removed when compared with the number present in the milk. In fact, clarification has practically no effect on the keeping quality of the milk.

33. Straining of Milk.—The straining of milk through a cloth or a quantity of cotton more or less efficiently removes

any insoluble particles that may be present, but any bacteria adhering to these particles are washed off and remain in the milk, for no cloth or filter used for straining milk is of fine enough mesh to hold the bacteria. In Fig. 10 is illustrated the relative sizes of fat globules of milk and the most common kinds of bacteria found in milk. The fat globules are shown at *a* and groups of bacteria at *b*. From a study of this illustration it is evident that any cloth or filter of sufficiently fine mesh to remove the bacteria would at the same time remove the fat globules.

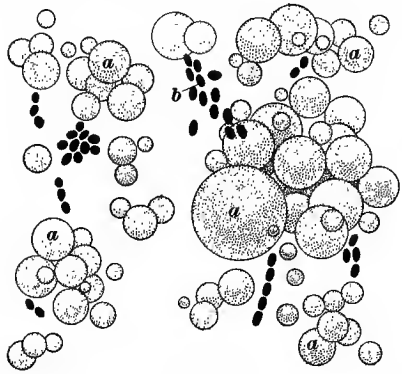


FIG. 10

34. Cooling and Storing of Milk.—As bacteria multiply more rapidly at high than at low temperatures, milk will become sour more quickly if kept at a high temperature than if kept at a low temperature. For this reason, milk will keep longer if cooled rapidly soon after it is drawn than if it is allowed to cool slowly or is allowed to remain at a fairly high temperature. Experience shows that if milk is cooled to about 50° F. immediately after it is drawn from the cow, it will contain fewer bacteria than if cooled slowly. Fig. 11

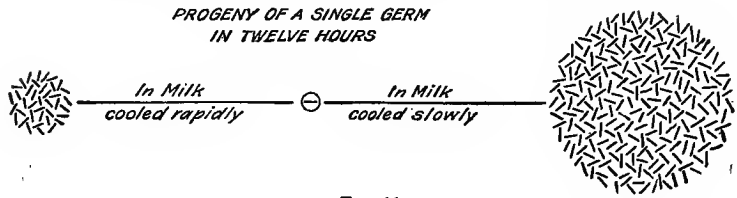


FIG. 11

illustrates the relative number of bacteria produced in 12 hours from a single germ in milk when it is cooled rapidly with cold water and when it is allowed to cool slowly.

Milk may be cooled in a number of ways. When the quantity to be treated is small, it may be placed in a tall, narrow can and the can placed in cold water. Stirring the milk in the can will hasten the cooling to a great extent. When a large quantity is to be treated, a device known as a *milk cooler* is employed. The most efficient coolers are those in which the milk is allowed to flow in a very thin stream over a metal surface on the opposite side of which is cold water, or water and ice. Fig. 12 shows a cooler of this type. The cold water and ice are placed inside of the metal vessel *a*, the milk is placed in the receptacle *b*, from whence it flows over the corrugated surface of *a* to the base of the cooler *c*, and eventually out of the spout *d*. The spouts *e* and *f* are the inlet and outlet tubes for use when running water is available. In use, the inlet tube is connected with the water supply by means of a rubber hose. The outlet, or discharge, is so arranged that the water is carried off from the top of the vessel *a*. With running water, the milk will be cooled to within a few degrees of the temperature of the water. If an abundance of water having a temperature not above 55° F. is available, no ice need be used in the cooler, but when water is scarce or its temperature too high, ice should be used.

FIG. 12

After milk has been run through a cooler it should be placed in cans or bottles in cold water. Care should be taken that no milk is spilled into the vats or tanks used to hold the water, especially if the same water is used for several days in succession. Milk in water furnishes food for bacteria, and if the water becomes warm conditions will be favorable for a rapid bacterial growth, and as a result pronounced odors soon rise from the tank. If possible, fresh water should be used daily, as there will then be little chance for bacteria to

reproduce sufficiently to cause odors. If perchance some milk is spilled into the tank and it is not expedient to change the water, a few pieces of unslaked lime added to the tank will prevent the development of bacterial odors.

Milk that has been cooled should, of course, be stored in a cool place, but the temperature should not be below the freezing point, as freezing causes the separation of the fat and casein in such a manner that they cannot be reincorporated. A temperature just above the freezing point is satisfactory, for at this temperature the milk will remain sweet for a long time. A word of precaution is necessary, however, about the storing of milk. Although the bacteria that cause milk to sour do not develop at low temperatures, certain bacteria that cause putrefaction do develop, and as a result milk that has been stored for a long time may be perfectly sweet, but at the same time it may contain bacteria that are harmful to man. For this reason milk should not be stored for more than 48 hours, and preferably 24 hours, before it is consumed.

35. Use of Preservatives in Milk.—The growth of bacteria in milk can be inhibited by the use of such preservatives as boric acid and formaldehyde. However, since these preservatives are injurious to human health, their use as a milk preservative is, as a rule, prohibited. When use is made of a preservative, formaldehyde is more often employed than boric acid, because the former is less expensive and more effective. Formaldehyde used at the rate of 1 part to 25,000 parts of milk will act as an efficient preservative and will prevent milk from souring for from 24 to 48 hours; hence, there is great temptation for its use, especially in the case of the dealer who has milk that cannot be disposed of at once.

36. Controlling Bacteria by Heat—The bacteria that cause souring of milk are almost certain to be killed by boiling the milk, but there are certain putrefactive bacteria that the boiling temperature will not kill. Any injurious bacteria will not be present in any considerable numbers in the milk until after 24 to 48 hours. Boiled milk, therefore, is perfectly healthful if used within, say, 24 to 36 hours; after about

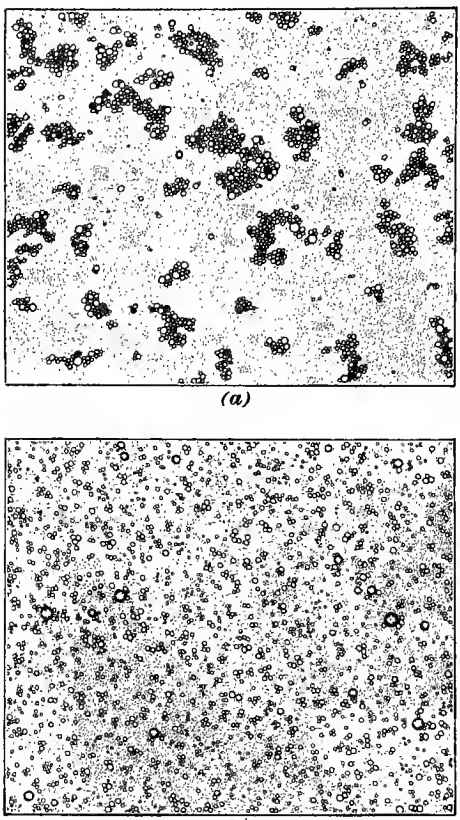
48 hours it is likely to be harmful as human food. Although boiling is a means of controlling the number of bacteria in milk, there are several objections to this method of treatment. Boiled milk is not easily digested and assimilated by the human body; the boiled taste is very apparent and is objected to by most people; and there is always the danger that the milk will be a day or so old, and hence likely to contain putrefactive bacteria. In view of these facts, boiling is not a good method of controlling the number of bacteria in milk.

37. A method of controlling the number of bacteria in milk by heat that is more satisfactory than boiling is that of *pasteurization.* Liquids are pasteurized by heating them to a temperature somewhat below the boiling point, averaging in practice from 140° F. to 180° F., keeping them at that temperature for a given period of time, and then cooling them rapidly. In milk treated thus, the bacteria that cause milk to sour, and most disease-producing forms, are destroyed. Certain spore forms that grow rapidly when acidity is not present are not killed by the heat of pasteurization, and for this reason the milk should be used before it becomes old, say in from 24 to 48 hours.

The temperature used for the pasteurization of milk is important. If as high as 185° F. is employed, the milk will have a cooked taste; and if the temperature is as low as about 120° F., a large portion of the bacteria will not be killed. The temperature required for pasteurization varies with the length of time the milk is subjected to the heat—the higher the temperature, the shorter is the time required. The city of New York has the following regulations, which may be taken as a guide: 158° for 3 minutes, 155° for 5 minutes, 152° for 10 minutes, 148° for 15 minutes, 145° for 18 minutes, 140° for 20 minutes.

As a rule, pasteurization is more effective when the heating is done for 15 to 20 minutes at the temperatures indicated for these lengths of time, than when done for a short time, say 3 to 5 minutes, at higher temperatures.

38. A scum forms on milk heated in open vessels, unless it is agitated during the heating, and since a scum is undesirable on milk that is offered for sale, and as it serves as a protection to the bacteria embedded in it, precautions are generally taken to prevent it from forming. Milk that is agitated creams slowly on account of the aggregations of fat globules being broken apart. The individual globules are smaller than the aggregations and thus they take a longer time to reach the surface. In Fig. 13 (*a*) is illustrated a magnified group of fat globules of unheated milk, and in (*b*) a group of fat globules of pasteurized mllk. It can be noticed that aggregations of globules are practically absent in (*b*). The temperature to which milk is heated also has an effect on the creaming property; the higher the temperature, the slower is the creaming.



(*a*)

(*b*)

FIG. 13

Fig. 14, which is made from a photograph of actual conditions, illustrates the effect of heat on the creaming of milk. A quantity of milk was divided into three parts, and one part was left unheated and the other parts were heated to different temperatures for different lengths of

time. In cylinder *a* was placed the unheated milk; in *b*, milk that had been heated to 147° F. for 15 minutes; in *c*, milk that had been heated to 180° F. for 1 minute. The line *e* in each cylinder marks the separation between the cream and the milk after the cylinders had been allowed to stand undisturbed for 24 hours. It can be seen that more cream is on the surface of the unheated milk than is on either of the quantities heated, and that there is an exceedingly small quantity of cream on that heated to 180° F. If milk is pasteurized in a bottle, no scum will form on the surface, consequently there is no need to agitate the milk during the process, and since there is no breaking apart of the aggregations of fat globules by agitation, milk pasteurized in bottles creams nearly as well as unheated milk.

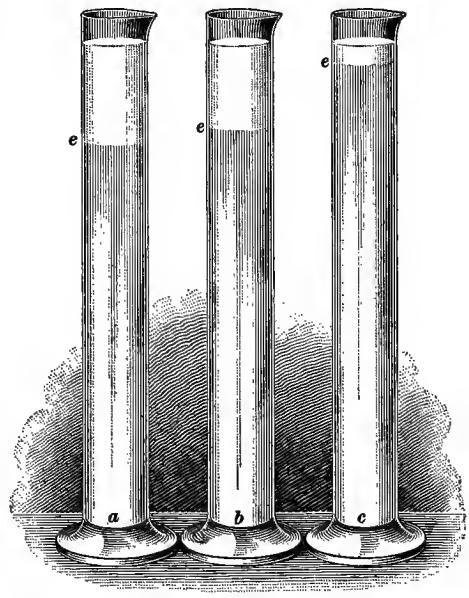


FIG. 14

The same factors that cause milk raised to a high temperature to cream very slowly also affect cream. Pasteurized cream appears much thinner than raw cream. This is a distinct disadvantage to dealers, as consumers are likely to think the cream is of poor quality.

39. Persons often think that all milk that is not sour is fit for use. Long before souring takes place in pasteurized milk, it is likely to be unfit for use as human food. It is important, therefore, that pasteurized milk be sold as such and that the consumer recognizes the fact that the milk

should be used within a short time. The city of New York requires that milk sold as pasteurized shall be marked as such, and that the date and hour when it was pasteurized be indicated on the bottle; it must be delivered to the customer within 24 hours, and must not be pasteurized a second time.

The quality of pasteurized milk depends on the quality of the milk treated. If the raw milk is old and contains many bacteria, the pasteurized milk will have a poor keeping quality; indeed, it may spoil almost as rapidly as if unpasteurized. On the contrary, if the milk is fresh and contains few bacteria, the pasteurized product will be of good quality.

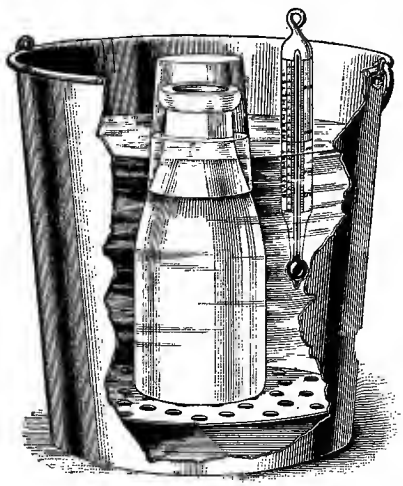


FIG. 15

40. In the home it is often desirable to pasteurize milk, especially when it is used for children or when it cannot be obtained from herds that are known to be healthy. For home pasteurization, milk should be heated in the bottles in which it is delivered. A simple form of apparatus is illustrated in Fig. 15. A false perforated bottom is placed in the pail, and the pail is filled with cold water to the height indicated in the illustration. The bottle of milk is then covered and placed in the water, the purpose of the cover being to prevent a scum from forming on the surface and to prevent dust from getting into the bottle. The water is then heated to about 155° F. and kept at this temperature for about 20 minutes. A floating dairy thermometer like the one illustrated is a handy kind for determining the temperature. The milk in the bottle will become nearly as hot as the water in the pail, and if the water in the pail is kept at 155° F. for the time indicated the milk will be sufficiently pasteurized. After the milk has

been heated, it should be cooled as soon as possible. This can be done by running cold water into the pail slowly or by placing the bottle in several changes of cold water, taking care not to place the hot bottle in very cold water at first. Milk heated as here described, should never be allowed to cool slowly, not even by placing it in an ice box, for any bacteria that may have resisted the effect of the heat would grow rapidly at such a favorable temperature and the milk would soon spoil.

If a large quantity of milk is to be pasteurized in the home, use can be made of tall cans 4 or 5 inches in diameter; these are placed in water in a wash boiler, as illustrated in Fig. 16. A false bottom should be provided to prevent the excessive

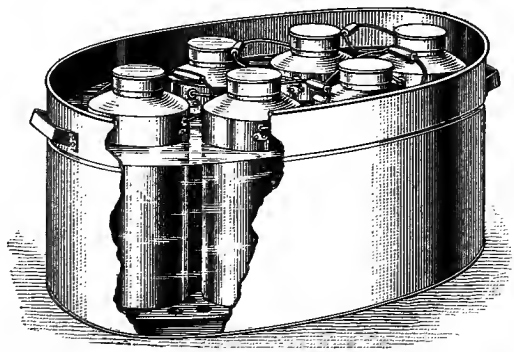


FIG. 16

heating of the milk on the bottom of the cans. Cans having a larger diameter are unsatisfactory on account of the milk in the center of the can not being heated as quickly as that near the side. The cans should, of course, be provided with covers. The water should be heated to a temperature of about 155° F. and this temperature retained for about 20 minutes, after which the cans should be cooled quickly. Care should be taken not to allow the water to become much hotter than 155° F. or the milk may have a burned taste.

In creameries, large dairies, etc., use is made of pasteurizing machines. These do very efficient work, but they are entirely impracticable for use on farms where only a small quantity of milk is pasteurized daily.

PRESERVED MILK

41. Condensed Milk.—Liquids thick with sugar are not favorable mediums for bacterial growth. The condensed-milk manufacturer makes use of this fact in the making of his product. The milk is heated, cane sugar is added, and the milk is condensed in vacuum pans to about one-third of the original volume. The heating is not sufficient to destroy the bacteria, but they are unable to grow until the milk is diluted with water.

42. Evaporated Milk.—Evaporated milk is made by evaporating milk to about one-third of the original volume. It is then placed in cans and is sterilized by heating to 250° F. from 15 to 20 minutes. The milk is thus freed from living bacteria and will keep as long as it remains in the cans unopened. It will spoil, however, if not used within a few days after it is exposed to the air.

43. Milk Powder.—If milk is heated until all the water is evaporated, a powder composed of the milk solids results. This product, known as milk powder, is often used by bakers in place of fresh milk. It keeps well if it has been prepared from skim milk, but if made from whole milk, the fat becomes rancid in a comparatively short time, and thus the flavor of the product is injured.

MILK FERMENTATIONS

44. Most of the known forms of bacteria are able to live and reproduce in milk. As a rule, however, only a few forms are common to milk. The changes caused by these bacteria are known as fermentations and most of them are familiar to persons who handle milk.

45. Acid Fermentations.—The fermentation most commonly found in milk is that which causes it to become acid. The bacteria that are responsible for this change are known as *acid-forming bacteria;* there are several varieties of these, but

only two have anything to do with the ordinary souring of milk. Bacteria of these two varieties grow more rapidly than those of any other kind, and on this account souring is the most noticeable change, aside from creaming, that occurs in milk. In fact, souring is regarded as such a natural change that milk in which it does not appear is looked upon with suspicion, and justly so.

The two varieties of bacteria that cause the ordinary souring of milk are widely distributed, and unless precautions are taken they enter milk in large numbers, but no matter how many of them there are in milk, the acidity rarely exceeds 1 per cent. The reason for so low a percentage is that the bacteria cannot grow when the acidity exceeds 1 per cent. One kind is sometimes called the *desirable acid-forming bacteria*, as they are useful in the manufacture of butter and cheese. They impart to these products desirable flavors that cannot be otherwise obtained. Because the acid they produce in the milk is lactic acid, they are known also as *lactic-acid bacteria*. These desirable acid-forming bacteria are more likely to cause the souring of milk that has been produced under clean conditions than if the surroundings are dirty. In fresh milk produced under clean conditions but few of the bacteria will be present, but when temperature conditions are favorable they reproduce rapidly and soon crowd out other forms. Milk soured by them becomes a solid mass of curd, free from holes, and the curd can be broken to form a creamy mass. Milk soured by lactic-acid bacteria has an agreeable acid taste, a characteristic odor, and is a healthful, appetizing food.

Bacteria of the second class produce a gas in the process of fermentation, and for this reason they are known as *gas-forming bacteria*. They are more prevalent in dirty milk than in clean milk, and are much less desirable than the lactic-acid form. They produce about the same quantity of acid as do lactic-acid bacteria, but the curd formed in the milk is not uniform and is filled with holes, due to the gas that is formed, and this curd shrinks, becomes tough, and cannot be broken into a creamy mass. Milk soured by the gas-

forming bacteria has a disagreeable taste, an offensive odor, and is not a healthful food; the flavor of butter and cheese made from such milk is undesirable, and for this reason the products are disliked by consumers.

The appearance of samples of milk soured by the lactic-acid and by the gas-forming bacteria is illustrated in Fig. 17. The milk in cylinder *a* was fermented by lactic-acid bacteria and that in cylinder *b* by gas-forming bacteria. It can be seen that the curd shown in *a* is formed into a solid mass free from holes, and that the curd in *b* is full of gas holes and that it has shrunk until it occupies a smaller space than does the curd in *a*.

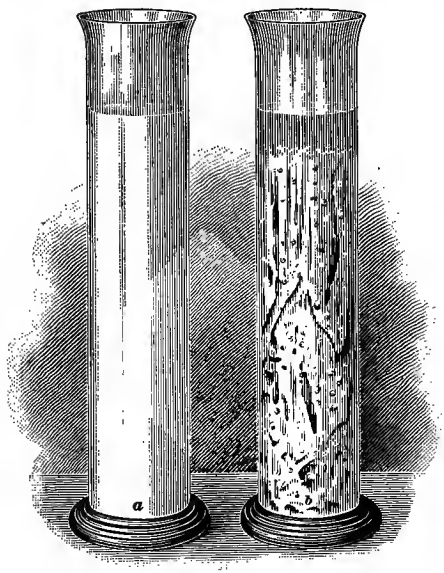


FIG. 17

46. Acid-forming bacteria, other than the two kinds just described, are present in milk in small numbers, and at ordinary temperatures grow very slowly; hence they have nothing to do with the ordinary souring of milk. A sample of milk that has been soured by these bacteria can be obtained by filling a bottle full of raw milk, closing the top to shut out the air, and then allowing the bottle to remain in a warm place for about two weeks. On examination at the end of the time it will be found that the milk has an intensely acid taste that resembles unsweetened lemonade. The curd of the milk can be broken into particles that will remain in suspension as in buttermilk, and if used cold and sweetened with sugar, milk fermented in this manner forms a pleasant beverage.

All acid-forming bacteria are instrumental in preventing the growth of putrefactive forms of bacteria. None of the putrefactive bacteria can grow in an acid substance, and as acid is soon formed in milk by the development of acid-forming bacteria, unheated, or raw, milk becomes a medium unfavorable to the growth of putrefactive forms. This seems an important provision of nature, for, were it not for the development of the acid-forming bacteria, milk in a comparatively brief time after it was drawn would become an offensive, ill-smelling, unhealthful substance.

The acid condition of milk is useful in the manufacture of butter, which, as a rule, is made from cream that has been allowed to sour. Butter made from sour cream has a desirable flavor and good keeping quality, but that from sweet cream has little flavor and is poor in keeping quality. In making butter, it is desirable that only lactic-acid bacteria ferment the cream, as the gas-forming and other acid-forming kinds injure the butter flavor. Butter makers are able to control the kind of bacteria that sour the cream by first pasteurizing the cream to kill all acid-forming bacteria and then adding a pure culture of lactic-acid bacteria known as a starter. A culture of this kind will usually sour the cream in the manner desired.

In addition to being useful to the butter manufacturer, acid-forming bacteria are very important in cheese making. They are helpful in the ripening process, for if none are present cheese does not ripen. The presence of the bacteria also protects the cheese against attacks of putrefactive bacteria through the acid formed by an action similar to that noted in the case of milk.

47. Milk that has undergone acid fermentation is used as food in a number of ways. Buttermilk, which is sour milk in which the curd is finely divided, is much relished as an article of diet by some people. In buttermilk obtained by churning, the curd is so very finely divided that it does not settle on standing. This is due to the agitation of the milk during the churning process and to the presence of the

butter, which prevents the curd from forming into hard masses. Buttermilk made by churning cream for butter is known as natural buttermilk. A product known as artificial buttermilk can be formed by stirring sour milk vigorously for a time. The product has the exact taste of natural buttermilk, but the curd does not stay in suspension for so long a time. In both natural and artificial buttermilk, the taste is much milder when lactic-acid bacteria sour the milk or cream than when any other forms have caused the souring. As a rule, therefore, if a starter is employed in souring the milk, a milder product is secured than if the milk is allowed to sour without the addition of a starter. Another form of artificial buttermilk can be made by placing in whole milk pure-culture tablets of lactic-acid germs, which can be procured from druggists and other dealers. After the addition of the tablets the milk is agitated and placed at ordinary room temperature for about 24 hours, after which it is again agitated to break up the curd that has formed. The number of tablets to use with a certain quantity of milk is specified on the package in which they are sold.

Cottage cheese is another product that may be considered as a form of sour milk, since it is the curd of sour milk from which the whey has been removed by straining. Like buttermilk, cottage cheese is of a milder flavor when a starter is used in souring the milk than when none is used.

48. Sweet Curdling of Milk.—Under certain conditions milk curdles but still remains perfectly sweet. This change is caused by certain bacteria that do not develop in an acid medium, and it is seen, therefore, more often in heated than in raw milk. The curd that forms is soft and mushy, and gradually disappears, due to certain functions of the bacteria. It sometimes happens that raw milk does not sour naturally, and when this is the case sweet curdling is likely to occur.

49. Butyric Fermentation.—There are always present in milk small numbers of bacteria that produce what is known as butyric acid, which is an acid that has a disagreeable odor like that of rancid butter. These butyric-acid bacteria

are seldom found in large numbers in raw milk, for they cannot compete with the lactic-acid and gas-forming bacteria. In pasteurized milk, however, especially if it is three or four days old, many of this class of bacteria are likely to be present. The curd that is formed when butyric fermentation occurs in milk is full of gas holes and has a disagreeable odor and a very bitter taste.

50. Ropy Milk.—Milk sometimes becomes slimy, or ropy, on account of the growth of bacteria in it, and the contamination can be transferred from one quantity to another simply by transferring some of the ropy milk to a vessel containing milk that is free from this condition. There are several kinds of bacteria that cause ropiness of milk, but the one that most frequently produces this change lives only in the upper layers of the milk. Ropiness caused by this form of bacteria is often seen in bottled milk that is kept at low temperatures, and is apparent when the cream that has risen to the top of the milk is turned from the bottle. It is thought that the bacteria gain entrance to the milk either from water used in washing the milk utensils or from water in pastures or feed lots that may have soiled the udders and flanks of the cattle. During the warm season of the year outbreaks of ropiness sometimes occur in the milk of a herd, and cause trouble and loss to the owners.

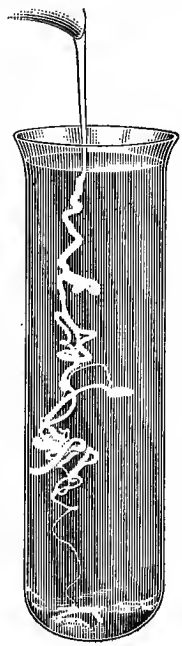


FIG. 18

Some kinds of lactic-acid bacteria produce a ropiness in milk, but the occurrence is rare. Bacteria of this kind are found in a slimy milk of Norway, which has the taste and odor of good buttermilk and is used as a beverage in the country mentioned. It is often so slimy that it can be drawn out into long threads as fine as those of a spider's web. Milk of this kind does not mix readily with water, as may be learned by an examination of Fig. 18, which shows the appear-

ance of the milk when it is poured into water. The whey that is used in the manufacture of Edam cheese in Holland is also of a slimy nature.

51. Bitter Milk.—Some forms of bacteria produce a bitterness in milk that in many cases is very pronounced. Certain of the acid-forming kinds sometimes cause an intense bitterness, which may be so noticeable as to mask the otherwise acid taste. Bitterness sometimes occurs in old pasteurized milk and is due to the growth of certain of the putrefying bacteria that were not killed by the heat. Unpasteurized milk that is stored at a low temperature for a long time may develop a bitterness, as the low temperature prevents lactic-acid bacteria from developing, but there are certain other forms that can grow, and it is the growth of these that produces the bitterness.

52. Alcoholic Fermentation.—There are certain yeasts in milk that ferment milk sugar, forming, as a result, alcohol and carbon dioxide. However, milk sugar does not undergo fermentation so easily as other sugars, and for this reason alcoholic fermentation is less likely to occur in milk than in many other substances. Since yeasts grow best in acid substances, alcoholic fermentation, when it is found in milk, appears in sour milk, buttermilk, or whey.

A fermented beverage called koumiss is made by the alcoholic fermentation of milk. Mare's milk is generally used for the purpose, as this kind of milk undergoes fermentation rapidly on account of containing a large percentage of milk sugar. The drink, which is used principally in Southeastern Russia, is effervescing and has an agreeable and characteristic flavor. In the United States, a similar drink that is known by the same name is prepared by adding cane sugar to cow's milk and then inoculating it with baker's yeast. The milk sours, due to the action of lactic-acid bacteria, and the yeast ferments the cane sugar.

Kefir is a beverage similar to koumiss that is used principally in Russia, although it is found to a limited extent in the United States. What are known as kefir grains are

employed in the manufacture of this product. These are dried masses of yeasts and acid-forming bacteria that have the power of starting alcoholic fermentation in cow's milk. When making the beverage the dried kefir grains are soaked in water and then added to the milk, and after the milk is fermented the grains are removed and placed in fresh milk if more kefir is desired or they are redried for future use.

53. Colored Milks.—Several kinds of bacteria produce color in milk, but the occurrence is rather rare. Among the colors occasionally occurring in milk, due to bacteria, are blue, red, orange, green, yellow, amber, chocolate, and even black. Milks containing these colors are, however, of rare occurrence. Red milk that is not caused by bacteria sometimes occurs in dairies. Blood discharged into the udder because of a wound or a severe attack of inflammation may become mixed with the milk and impart to it a red color. When the color is due to blood, it will be present at the time the milk is drawn, and after the milk has stood for a time the blood corpuscles will settle to the bottom of the containing vessel. If the red color is due to bacteria it will not appear at once, and will most often be seen at the surface of the milk.

PATHOGENIC BACTERIA IN MILK

54. As may be inferred from previous statements, milk may contain many kinds of disease-producing bacteria. Technically, these are known as **pathogenic bacteria.** They may be grouped into two general classes—those that are due to a diseased condition of the cow giving the milk, and those that are due to diseases of man and transmitted from one person to another through the medium of milk. Tuberculosis, garget, mammitis, foot and mouth disease, cow pox, digestive troubles, and inflammation of the uterus are among the diseases of cattle that may cause trouble and suffering in the human family if milk from diseased animals is used as food. Therefore, whenever a dairyman finds any of these diseases in his herd he should immediately stop selling the

milk and take measures to have the diseased animals treated. In fact, he should stop selling milk if the cows are sick with any disease, whether it is a bacterial disease or not, for milk from sick animals is very likely to be unfit for use as human food. The descriptions, symptoms, tests, methods of treatment, etc. of the animal diseases referred to in this article are described in a subsequent Section.

The diseases of mankind that may be transmitted by milk are those bacteriological diseases that infect through the alimentary tract. Typhoid fever and diphtheria are often carried by milk, and it has been claimed that at least a few epidemics of scarlet fever have been caused by the contamination of milk with scarlet-fever germs. In view of the fact that diseases are often transmitted by milk, great care should be exercised by dairymen and consumers to prevent infection. If any of the germ diseases mentioned above are near a dairy, the milk should not be used until all danger of infection is over, or if one of the diseases is in the family of a person employed about the dairy, he should not be allowed to handle any of the utensils used for milk, nor should he be allowed to come in contact with the milk in any manner. In fact, precautionary measures should be taken if there is any kind of sickness about the houses of dairymen. Of course, not all diseases of the human family are transmissible by milk, but it is a good plan, no matter what disease is in the home, to ascertain from a competent physician whether or not there is any danger of infection being carried in the milk, and to be governed accordingly.

TESTS OF BACTERIA IN MILK

55. It is often desired to test milk for the relative number and the different kinds of bacteria contained therein. One method of testing for the relative number is to determine the quantity of dirt in the milk. If a large quantity is present, bacteria are sure to be there in large numbers. A comparative determination of the quantity of dirt in several lots of milk can be made by filtering a like quantity from each

lot, say a quart or a pint, through small disks of absorbent cotton. The relative quantity of dirt in the different lots is ascertained by the color imparted to the disks of cotton, the lighter colored the cotton the cleaner the milk, and conversely. Fig. 19 is a drawing made from a test as here outlined. One pint from each of four lots of milk was filtered

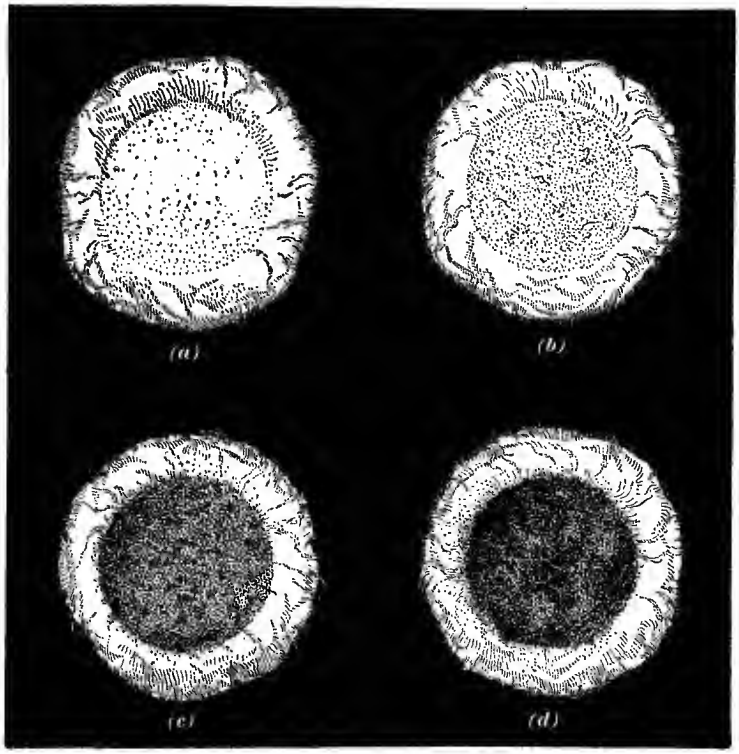


FIG. 19

through cotton disks. The milk that passed through disk (*a*) was comparatively clean; that through disk (*b*) was slightly dirty; that through disk (*c*) was what may be termed dirty; and that through disk (*d*) was very dirty. The milk that passed through disk (*d*) contained more bacteria than that poured through disk (*c*), and so on through all the lots of milk.

56. What is known as a fermentation test gives some idea of the kind of bacteria in milk. A simple way of making a test of this kind is to place a quantity of milk in a glass vessel and keep the milk at a temperature of 95° F. to 100° F. for 24 hours. If by this time the milk is sour and shows a solid, homogeneous curd and little or no free whey, like the milk in cylinder *a*, Fig. 17, conditions indicate that the milk was raw and that the fermentation is due to lactic-acid bacteria; if the milk is sour and the curd is filled with gas holes and has contracted into a small cake, as shown in cylinder *b*, Fig. 17, the indications are that the milk was raw and that the fermentation is due to gas-forming bacteria; if the milk does not curdle or if the curd is soft and mushy, conditions indicate that bacteria that cause sweet curdling of milk are probably present or that the milk has been pasteurized. As stated previously, lactic-acid bacteria are desirable for the souring of milk.

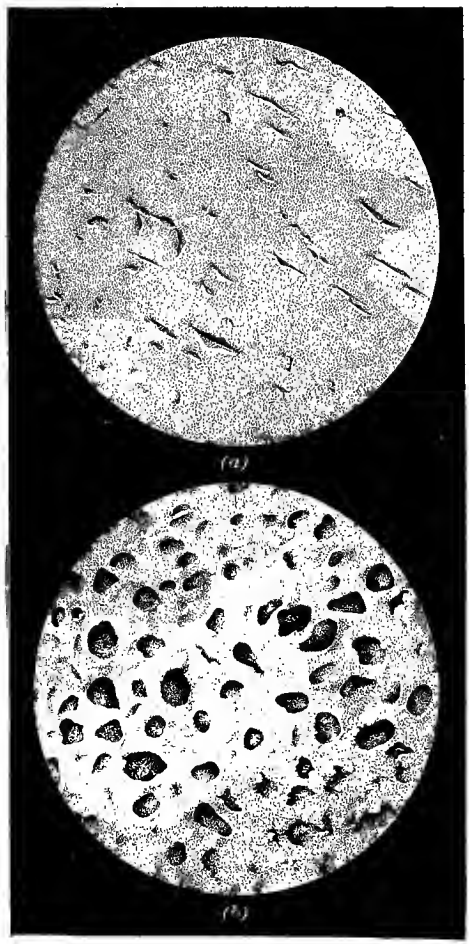


FIG. 20

57. Another method, known as the Wisconsin curd test, of determining the kind of bacteria in milk is as follows: Pint fruit jars are cleaned and then sterilized with boiling water; a jar is filled from each of the samples of milk to be tested; the milk is heated to 90° F. and 10 drops of rennet is added to each jar; the milk is then stirred until the rennet is thoroughly mixed with the milk, and the jars are allowed to stand quietly until a firm curd has formed, which will require from 10 to 15 minutes. Each curd is then cut into small pieces with a sterilized case knife, which facilitates the expulsion of the whey. As the whey collects it is turned off, and the curd soon forms a small cake that encloses practically all of the bacteria that were in the milk. The curds are kept at about 100° F. for from 10 to 15 hours; they are then removed from the jars and examined as to odor and the presence of gas holes. A solid curd, such as is illustrated in Fig. 20 (*a*), that has an agreeable odor is an indication of good milk that was fermented by lactic-acid-forming bacteria; a spongy curd, as shown in (*b*), indicates that likely the milk was produced under unclean conditions and that gas-forming bacteria were instrumental in the souring of the milk. This test is more delicate than the simple fermentation test and is often of great service in tracing the source of poor milk. It must, however, be made with great care to avoid all sources of error, as the operator must be certain that the undesirable bacteria found in the curd were present in the milk and were not introduced by the use of unclean jars or by the contamination of one sample of milk from another in taking the samples.

58. Some idea of both the number and kinds of bacteria in milk can be obtained by still another modification of the fermentation test. In making this test, use is made of a water solution of methylene blue. This is made as follows: From a druggist procure a few ounces of a saturated alcoholic solution of the dye, and mix 1 part of this alcoholic solution with 19 parts of water. To make the test, several small bottles or glass test tubes, the number depending on the

number of milk samples to be tested, are sterilized and filled with samples of milk. To each tube or bottle is added 15 drops of the water solution of methylene blue. This slightly colors the whole mass. Bacteria in the milk will gradually cause this color to disappear, the length of time depending on the number of bacteria present. The tubes or bottles are kept at about 100° F. If the blue color disappears in about 15 minutes, the milk contains a very large number of bacteria and has a very poor keeping quality; if from, say, 15 to 60 minutes are required, the bacteria are less numerous, but the milk is probably not a very good grade of market milk; if the color disappears in from 1 to 3 hours, the milk contains few bacteria and may be considered as of good quality; if more than three hours are required, the milk is low in bacteria and may be classed as a high-grade market milk. The dye does not interfere with the growth of bacteria, hence by noting the type of curd, the kinds of bacteria can be determined just as in the fermentation test.

ABSORPTION OF ODORS BY MILK

59. Milk has the property of absorbing and retaining certain odors, and the absorption will take place when the milk is either warm or cold. It is important, therefore, in dairy practice to keep milk in an atmosphere that is free from pronounced odors of any kind. Milk tainted by odors is not necessarily unhealthful, but it is unappetizing, and is sure to be objectionable to the consumer. In view of this fact, it is especially important that the air of the dairy stable be kept free from objectionable odors, especially during milking time.

Fermenting manures and feeds that have pronounced odors should be kept out of the stables. Silage is sometimes the cause of an odor in milk. If it is fed directly before the milk is drawn, the atmosphere of the barn will be filled with the silage odor and, as a result, the milk will be tainted; if, on the contrary, the feeding is done an hour or so before milking time and the barn is thoroughly aired there will be prac-

tically no silage odor in the milk. The keeping of other classes of animals, hogs for example, in a stable with dairy cattle is sometimes responsible for unpleasant odors in milk. If other animals are kept in a stable with cows, great care should be exercised in keeping their quarters clean and thus preventing the contamination of milk.

Ventilation of the dairy stable is necessary, not only for the health of the herd but for preventing the excessive so-called cowy odor that is too often noticed in stables, as a pronounced cowy odor is likely to taint the milk.

Care should be exercised to prevent undesirable odors in milk after it has been removed from the stable. Placing it in open vessels in cellars or rooms where there is an odor from decaying vegetables, etc. is a bad practice. Bright, clean rooms that have an untainted atmosphere are desirable storage places for milk.

The following experiment is suggested to show the ease with which milk absorbs odors. A banana from which the skin has been removed is allowed to remain for only 20 minutes in a tight box that holds a shallow pan of milk. The banana is then removed and the box closed and kept closed for 24 hours. At the expiration of the time, the box is opened and the milk examined to ascertain whether or not any of the banana odor is retained by the milk. In nearly every case a pronounced odor of banana can be detected.

MILK
(PART 2)

MARKET MILK

PROFITS IN MILK PRODUCTION

1. Cost of Producing Milk.—The cost of producing milk varies largely with the cost of feed and labor, and with the milk-producing power of the cow. Although the cost of feed and labor varies widely in different localities, it has been estimated that, as a rule, the value of the calf, the skim milk, and the manure produced by a cow will be approximately equivalent to the total expense of her keep other than that entailed by her feed. Thus, the farmer, knowing the cost of the feed used by his cows, and the market value of the butter fat produced by them, can determine to a reasonable degree of accuracy what profit his herd is returning to him. Of course, he must take into consideration the market value of the home-grown feed used by the cows in order to determine the approximate relative profit returned by the herd. For instance, if the market price of corn were 70 cents per bushel, the feeding of home-grown corn to milch cows would not be conducive to as great a relative profit in the producing of milk as would the feeding of home-grown corn that was worth only 35 cents per bushel, provided the price of milk was the same in both instances.

It is practically impossible to give exact figures as to the cost of the feed required to produce a given number of pounds of milk or of butter fat, owing to the fact that such important

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ENTERED AT STATIONERS' HALL, LONDON

considerations as the market price of feed, the portion of the year that cattle can be kept on pasture, etc., vary widely in different localities. In Table I are given figures, as determined by experiment, that show the cost in the states of New York, Minnesota, Missouri, and Utah of producing 100 pounds of milk and 1 pound of butter fat. A study of these figures will show the variability of the cost in different parts of the United States of producing milk and butter fat.

TABLE I

COST IN FOUR DIFFERENT STATES OF PRODUCING 100 POUNDS OF MILK AND 1 POUND OF BUTTER FAT

Name of State	Cost of Feed for	
	100 Pounds of Milk Cents	1 Pound of Butter Fat Cents
New York	95	$21\frac{7}{10}$
Minnesota	81	18
Missouri	88	21
Utah	63	15

2. Quantity of Milk Produced by Cows.—Two or more cows of equal weight, if given the same kind and quantity of feed and the same care, will, as a rule, produce widely different quantities of milk and butter fat. Table II illustrates what a difference there may be in the producing powers of cows. The figures given in the table were obtained by means of an experiment that was conducted in Illinois. Three cows were used in the experiment, and the table shows the number of pounds of milk and of butter fat that were produced in one year; the average per cent. of butter fat in the milk of each cow; the gross returns from each cow, assuming that the milk was worth $1.50 per hundredweight; the gross returns from each cow, assuming that the butter fat was worth 27 cents per pound; the cost of the feed for each cow; and the profit from each, based on the prices assumed.

TABLE II

COMPARISON OF THE PRODUCING POWER OF THREE COWS FOR ONE YEAR

Cow Number	Milk. Pounds	Butter Fat Per Cent.	Butter Fat Pounds	Gross Returns from Milk at $1.50 per Hundredweight	Gross Returns from Butter Fat at 27 Cents per Pound	Cost of Feed	Profit from Milk at $1.50 per Hundredweight	Profit from Butter Fat at 27 Cents per Pound
No. 1	3,399	4.58	156	$50.99	$42.12	$35.03	$ 15.96	$ 7.09
No. 2	10,059	3.79	381	150.89	102.87	38.01	112.88	64.86
No. 3	7,890	4.70	371	118.35	100.17	28.02	90.33	72.15

Many cows are kept that do not give nearly as large profits as those listed in Table II. In fact, many cows are kept that do not produce enough milk to pay for the feed they consume. Under such a condition, the farmer actually pays for the privilege of keeping the animals. In an experiment that was conducted in Illinois at the same time as the one just described, a cow was found that consumed in one year feed worth $17.83 more than the value of the milk she produced during that time.

3. Effect on Profits of Feed and Care of Cattle. — It should be borne in mind that feed and care have much to do with the yield of milk. Cows taken from a herd that has been poorly fed and otherwise improperly cared for and placed in a herd where they get better care will usually show an increased yield of milk. They will, however, do

better during the second period of lactation after such a change than during the first. The Cornell Experiment Station kept accurate records of the quantity of milk and of fat produced, and the cost of the feed for one year of 10 cows that were poorly fed and cared for. These ten cows were then taken to the station barn and fed and cared for in the best manner possible for two years. The increase in the yield of milk by ample feeding and good care over that by poor feeding and poor care was 46 per cent. The cost of the milk per 100 pounds

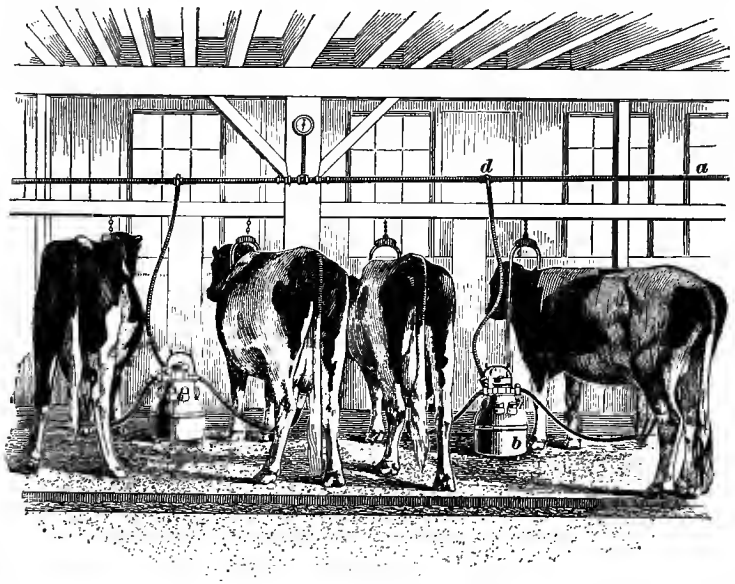


FIG. 1

during the period of insufficient feeding was 53 cents; during the period of ample feeding the cost was 45 cents.

4. Effect on Profits of Method of Milking.—The method of milking cows, whether by hand or by milking machines, has a considerable effect on the cost of producing milk. Experience shows that the labor problem on dairy farms is a serious one; not only are efficient dairy laborers difficult to obtain, but they are expensive to employ. Considering

these facts, it might seem that the use of milking machines, which minimize the amount of hand labor required on a dairy farm, would be economical. It has been proved by experiment, however, that for a small herd the cost of a machine and its installation is so large that hand labor is less expensive. Particularly for large dairies, such as those of about 24 cows and upwards, milking machines have been installed and in many cases, it is claimed, have been found economical and satisfactory. However, many dairymen with large herds maintain that the use of a milking machine is not as economical as hand labor. Some claim, also, that the machines on the market have not been perfected to the point where they are entirely satisfactory. Thus, at the present time it would seem that each dairyman must be guided by his own particular conditions in deciding whether milking by hand or by machine is the more economical. The manufacturers' price for a complete modern milking machine outfit for 24 cows is about $275.

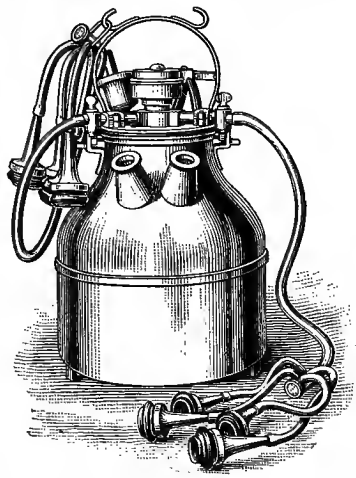


FIG. 2

An advantage of milking by machine over hand milking, besides that of being able to milk a larger number of cows with the same amount of help, is that there is a likelihood of the milk being cleaner and, therefore, of containing fewer bacteria. An interesting point in regard to milking machines is that experiments have been made which show that the use of modern types of machines does not interfere with the milk flow or with the length of the period of lactation.

5. The type of machine most widely used is known as the vacuum type. Two machines of this type are illustrated in Fig. 1. The pipe *a* is connected with a vacuum pump that

is operated by electric, gas, or steam power. The machine is provided with a tinned-steel pail *b* on top of which is a metal cover *c* that is termed a pulsator. This fits loosely on a gasket that makes an air-tight joint when the vacuum is

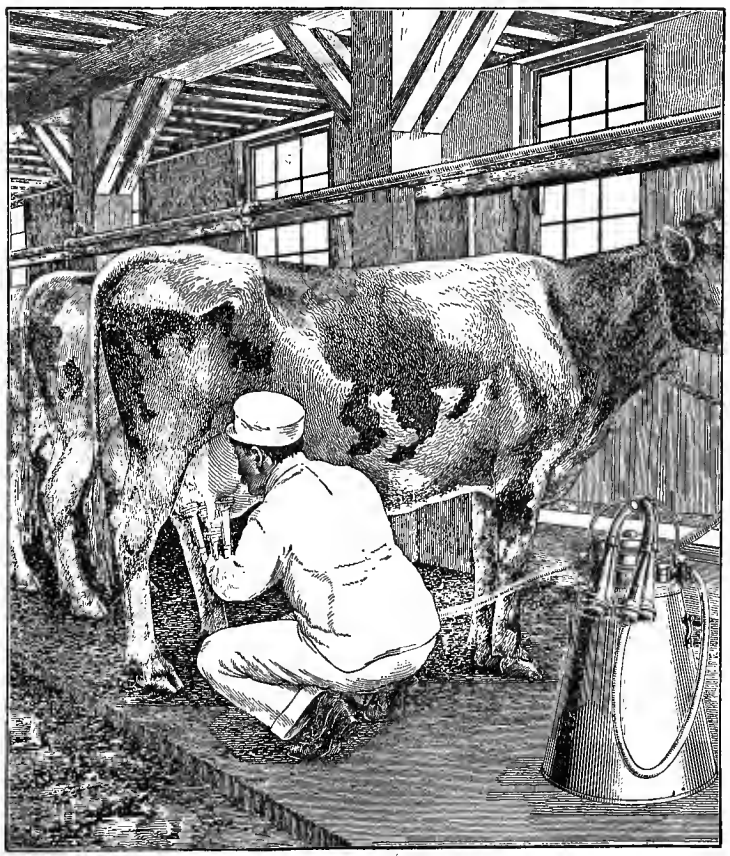


FIG. 3

created by the pump. The pulsator is connected by a single line of hose with a stanchion cock *d* on the pipe line, and has two pieces of hose, each of which has a group of four teat cups. When in use, each set of teat cups connects with the teats of an animal, and thus two animals are milked at a

time. The teat cups are held in place on the cow by suction. An enlarged view of a machine is shown in Fig. 2, and the position of the cups on a cow is shown in Fig. 3.

In the operation of the machine, the pulsator alternately makes and breaks the vacuum, which is caused by the vacuum pump, and thus draws the milk from the teats into the teat cups, from whence it is sucked through the hose to the pail. In the milk passage there is an inspection glass to permit the operator to see when the milk flow stops. After the milking has been completed the pulsator is removed and the milk is poured into pails or other receptacles.

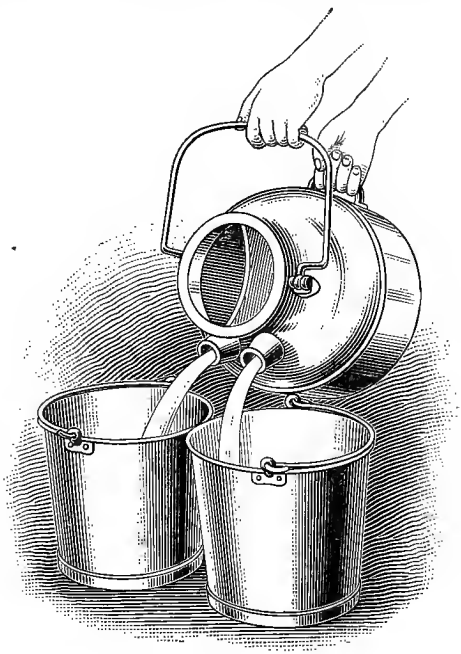


Fig. 4

The tinned-steel pails can be obtained in two styles, the partition and the standard. The advantage of the former type is that the milk from each cow milked can be kept separate, and, hence, a record kept of each animal. Fig. 4 illustrates the method of emptying the partition style of pail. By using a standard pail, the milk of both animals is mixed together, consequently individual records cannot be kept.

A form of milking machine that is operated alternately by vacuum, or suction, and compressed air is on the market. The vacuum draws the milk from the cow; the compressed air relieves the suction on the teats every second or two, and thus prevents certain ill effects that, it is claimed, result from continuous suction.

WEIGHING, TESTING, AND KEEPING OF RECORDS OF MILK

6. In order to determine whether a cow is a profitable one to keep, her owner must have a knowledge of the quantity of milk and butter fat that she produces in a year. Such knowledge can be secured only by keeping a record of the quantity of milk produced and of the per cent. of butter fat the milk contains. There are several ways in which this can be done. The milk of each milking from the cow can be weighed and a small sample taken for the determination of the per cent. of butter fat; or the milk can be weighed and sampled one day in each week, the figures thus obtained being used as an average for the seven days; or each day of every seventh week the milk can be weighed and sampled for testing. The latter method involves less work than either of the two preceding methods, and it has been shown to be accurate. The keeping of records should not be begun until at least three weeks after the cow has calved.

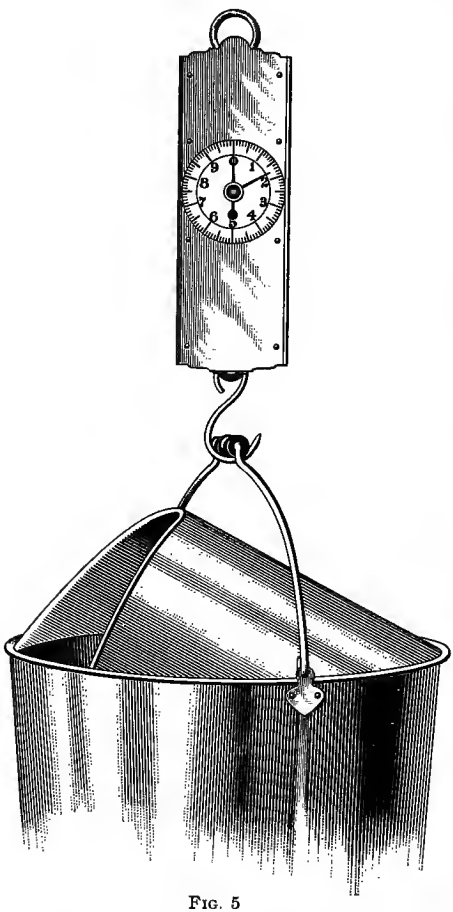


FIG. 5

242—23

SEVEN DAY MILK RECORD FOR TWENTY COWS

Maple Grove FARM

Daily Milk Record for Week Ending Nov 30, 1910

DATE	M—Morning E—Evening	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER	NAME OR NUMBER
		Elsie	Artie	Aggie	Pauline	Josie	Marion	Countess	Nellie	Jeanette	Irma	Adelaide	Sunlight	Phillis	Beauty	Maiden	Margaret	Johanna	Co-Ed	DeKol	Queen
		LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.
Nov. 23	M	7.0	16.1	5.2	16.3	13.5	9.3	9.1	10.3	17.0	5.8	13.2	9.7	8.7	7.4	14.2	28.4	29.0	26.9	25.0	8.7
	E	6.0	14.8	4.5	13.2	13.4	7.8	8.2	9.1	17.4	5.1	11.3	8.1	7.7	5.9	11.8	24.7	19.2	21.8	19.3	7.6
24	M	6.8	16.3	5.0	16.5	14.2	9.1	9.6	11.0	19.3	6.1	13.2	10.5	8.5	6.7	13.1	26.8	23.7	25.1	24.2	8.9
	E	6.0	14.8	4.3	14.0	11.7	8.0	8.9	10.0	19.9	5.3	12.6	8.6	7.9	5.6	11.5	22.0	21.5	22.5	17.6	7.0
25	M	6.8	15.3	5.0	17.5	12.9	8.7	10.2	12.9	20.1	5.9	13.3	10.6	8.2	7.3	14.2	29.6	27.3	26.6	21.8	9.5
	E	6.0	15.0	4.0	13.6	12.8	7.8	8.6	10.3	19.2	5.6	12.8	8.8	7.8	6.3	12.1	22.0	23.4	22.6	19.2	8.7
26	M	6.6	15.8	5.0	16.8	12.7	8.3	10.3	12.9	21.0	5.8	13.7	9.3	9.0	6.6	13.6	32.1	27.3	25.3	21.9	9.9
	E	5.5	14.0	3.5	13.8	11.7	7.6	8.5	10.9	19.4	5.7	12.9	8.2	7.5	5.7	12.5	22.5	23.3	22.4	18.3	9.2
27	M	6.1	16.3	4.0	16.7	11.6	9.5	10.0	14.1	20.4	6.0	14.0	10.1	8.6	7.5	13.8	32.2	28.5	25.7	23.4	11.2
	E	5.4	14.2	3.5	13.4	12.6	7.8	7.9	10.0	20.5	5.0	12.2	8.0	7.3	6.1	11.9	23.7	21.7	24.8	19.7	9.0
28	M	6.0	15.5	3.8	17.7	13.2	9.2	9.7	13.5	19.9	5.8	13.8	9.5	8.0	7.3	14.1	31.3	27.3	26.3	24.4	11.3
	E	5.0	14.0	3.5	14.0	13.3	7.6	8.5	11.5	20.8	5.0	12.8	8.8	8.0	5.0	11.4	24.5	21.9	21.7	19.5	9.4
29	M	6.3	17.1	3.5	16.0	11.6	8.6	9.7	12.1	19.6	5.8	13.2	9.0	8.2	8.2	12.7	30.6	28.2	25.0	23.8	10.6
	E	5.0	13.7	3.5	13.6	11.9	7.2	7.8	11.0	19.9	6.3	12.5	8.9	7.9	7.0	10.5	22.9	21.8	22.0	19.7	9.3
Total		84.5	212.9	28.3	212.7	177.1	116.5	127.0	159.6	274.4	78.3	181.5	128.1	113.5	92.6	177.4	372.3	344.1	339.8	297.8	130.3
% of Fat		3.90	3.30	3.30	3.40	4.90	3.70	4.35	4.15	4.00	3.65	3.65	4.50	5.00	6.20	4.50	4.33	3.45	3.18	3.60	5.30

FIG. 6

7. For the weighing of milk, a pair of automatic, spring-balanced scales, similar to that shown in Fig. 5, is convenient. There is placed on the dial of such scales a loose indicator that can be adjusted and set by a thumbscrew at the mark 0 so as to balance the weight of the empty pail. This same indicator thus shows the net weight of the milk after milking. Such scales have a second indicator that is used when general-purpose weighing is done. On account of the ease with which the results may be computed, a pair of scales that registers in pounds and tenths of a pound, like that shown in Fig. 5, is desirable. To avoid the necessity of readjusting the scales for each pail, all of the pails used in milking should be brought to the same weight; this can be done by adding solder, when necessary, to the bottom of each of the lighter pails.

FIG. 7

A record sheet of some kind should be kept near the place of weighing the milk, and on this sheet the quantity of milk that each cow produces should be recorded. Fig. 6 illustrates a record sheet that has spaces for the recording of the quantity of milk produced by each of 20 cows for 14 milkings, or in one week. The records given in the illustration are those of a herd of cows kept at the Agricultural Experiment Station of the University of Wisconsin. In the lower left-hand corner of the sheet is given the total number of pounds of milk produced by each cow during the week, and the average per cent. of butter fat for each animal.

8. For taking a sample of milk to determine the per cent. of butter fat, a small dipper that holds about $\frac{3}{4}$ ounce of milk should be provided. A form of dipper that is suitable for this purpose is illustrated in Fig. 7; such dippers can be purchased from dealers in dairy supplies. A cheap form of home-made dipper that will answer the purpose can be made by soldering a wire for a handle to a brass cartridge shell

of the size desired. The sample of milk should be taken from the total quantity drawn from the cow at one milking and the milk to be sampled should be thoroughly stirred before the sample is taken. This will permit of a representative sample being obtained. The samples should be placed in bottles, that taken from the milk of each cow being placed in a separate bottle. The bottles should be provided with some kind of cover to prevent evaporation of the milk. Either a Mason fruit jar or a milk bottle that is provided with a metal cap, such as the bottle shown in Fig. 8, is satisfactory for the purpose. Each jar or bottle should be marked with the number or the name of the cow from which the sample was obtained. When a sample from a cow is taken each day for several days and these daily samples are mixed together, the mixed sample thus obtained is called a **composite sample** of the milk of that cow. Composite sampling is commonly practiced in order to avoid making so many butter-fat tests as would otherwise be necessary. For instance, if milk is being tested every seventh week, a sample of each cow's milk can be taken at each milking during the week and these samples made into composite samples so that one test for each cow will be sufficient. Of course, in making tests of composite samples, it is advisable to make duplicate tests of each such sample as a check against error in any of the test manipulations.

FIG. 8

9. In making composite samples, or under any conditions where the milk must be kept in the bottles for several days, it is necessary to add some kind of a preservative. There are on the market a large number of different milk preservatives, such as bichromate of potash, formaldehyde, corrosive sublimate, and similar compounds; of these, corrosive sublimate is commonly considered to be the most satisfactory. This material is put on the market in tablet form for use as a milk preservative, the tablets containing a coloring matter, which, when dissolved, colors milk so that it can be readily dis-

tinguished as unfit for human food. Corrosive sublimate is a deadly poison and should be handled with care. As prepared for the preserving of milk, corrosive-sublimate tablets are commonly made in two sizes; those of one size are of sufficient strength that one tablet will preserve from 8 to 10 ounces of milk for four weeks; those of the other size are such that one tablet will preserve a similar quantity of milk for two weeks. Dealers in dairy supplies and many druggists keep these tablets in stock. Dealers usually give

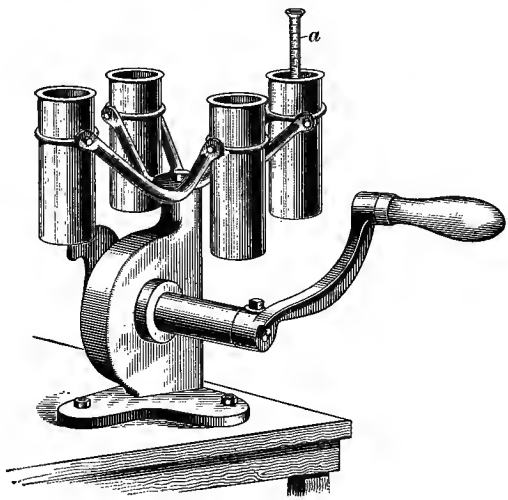


FIG. 9

specific directions for the use of any milk preservative which they sell.

10. The milk of each cow is weighed as soon as it has been drawn, the weight is recorded on the sheet provided for the purpose, and a sample is placed in the jar reserved for the milk of that animal. In case a composite sample is being made and other samples have previously been placed in the jar, the latter should be lightly shaken to mix the fresh milk with that already present and to break up the cream of the old milk, thus preventing it from drying on the sides of the bottle. If a composite sample is just being started, a cor-

rosive-sublimate tablet should be dropped into the bottle before or at the time of placing the first sample therein.

11. The percentage of fat in milk is determined by means of the Babcock test. The essential parts of one of the cheapest and simplest Babcock testing outfits on the market are shown in Figs. 9 and 10. In Fig. 9 is illustrated a centrifugal machine, or centrifuge, commonly called a tester, for making the Babcock test. In Fig. 10 (*a*) is shown a Babcock milk bottle, at least four of which should be provided; in (*b*), a glass pipette of 17.6 cubic centimeters capacity; and in (*c*), an acid measure of a capacity of 17.5 cubic centimeters. Such an outfit as the one illustrated can be purchased from dealers in dairy supplies.

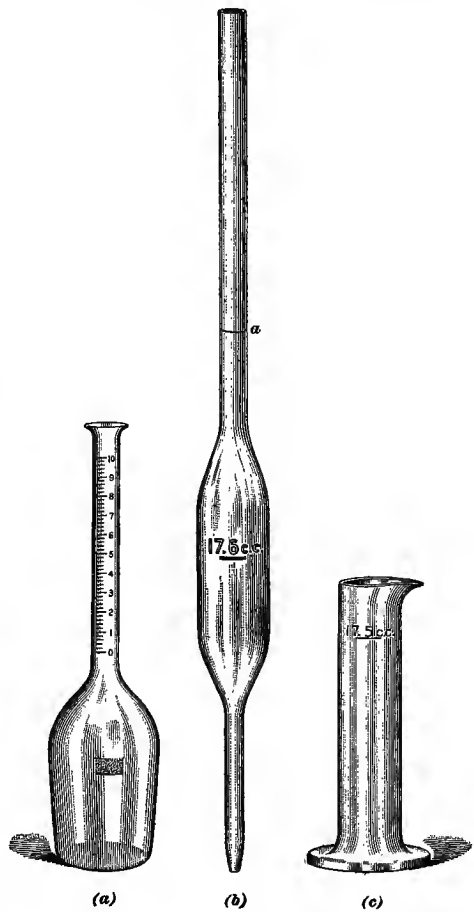


FIG. 10

The Babcock test is based on two facts: first, strong sulphuric acid, when added to milk, dissolves all of the solids except the butter fat; second, as butter fat is the only solid that remains after the milk has been treated with acid, it can be quickly separated from the remaining portion by cen-

trifugal force and its percentage directly ascertained by means of calibrations on the bottle. In the Babcock test a definite quantity of milk is used as a sample and a quantity of acid just sufficient to dissolve the solids is added. The mixture is then whirled in a centrifuge until a complete separation has been obtained. The butter fat is then brought into the neck of the test bottle by the addition of hot water, and the per cent. of fat that was in the sample is read directly from the calibrations.

12. The details of the testing of a sample of milk are as follows: First, the milk is thoroughly mixed by being poured from one vessel into another. For taking the required quantity of the sample for the test, a glass pipette, such as the one illustrated in Fig. 10 (*b*), is used. A quantity of milk is drawn up into the pipette with the mouth until the top of the milk is 1 or 2 inches above the line *a* that is etched on the pipette tube. The pipette is then removed from the mouth and the forefinger is quickly placed over the top of the tube. Due to atmospheric pressure without, the milk will remain in the pipette. The pressure of the forefinger is then slightly released and the milk is allowed to drop out of the tube until the top of the milk is on a level with the etched mark on the glass. There is then 17.6 cubic centimeters of milk in the tube, which is the quantity desired for testing. The point of

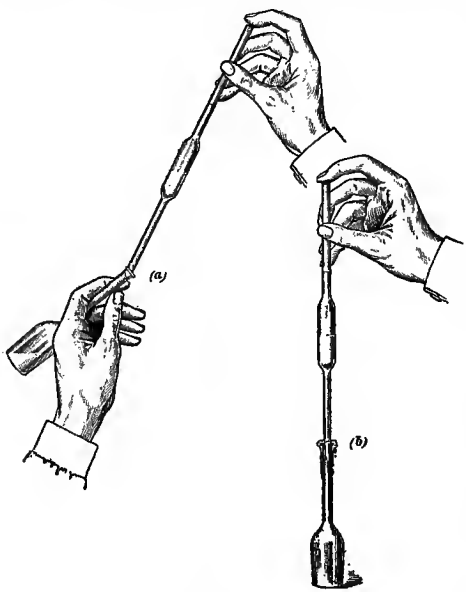


FIG. 11

the pipette is now placed in the neck of a test bottle such as the one illustrated in Fig. 10 (*a*), the bottle and pipette being held in a slanting position, as shown in Fig. 11 (*a*), and the milk is allowed to flow slowly into the bottle; the test bottle and pipette should never be held vertically, as shown in Fig. 11 (*b*), when milk is being transferred to the bottle, as there is likelihood that some of the milk may be spilled in the manner illustrated. Care must be exercised that no milk is spilled in any way. A small quantity will remain in the point of the pipette; this should be blown into the bottle. Next, the acid cylinder is filled with acid to the etched mark on the side that indicates 17.5 cubic centimeters; for the testing of milk, sulphuric acid of a specific gravity of 1.82 or 1.83 is used. The 17.5 cubic centimeters of acid is then poured into the test bottle, the bottle being held at an angle as before. The bottle should be turned around slowly as the acid is flowing down the neck; this washes any adhering milk into the bottle. It should be understood that the quantity of acid just given may not be exactly right for all samples, and it may be desirable, after some experience has been gained, to vary slightly from this quantity. If the acid has been poured into the milk carefully, the liquids will be in two distinct layers, with a band of partly mixed liquids between them. The acid and milk are next mixed together by gently rotating the test bottle in such a manner that the milk and acid are whirled round and round inside the bottle. The rotating should be continued until all clots of curd that form are completely dissolved. The mixing of the two liquids is accompanied by considerable heat and the milk becomes dark in color. After the mixing, the bottle is placed upright in the tester as shown at *a* in Fig. 9. It is desirable

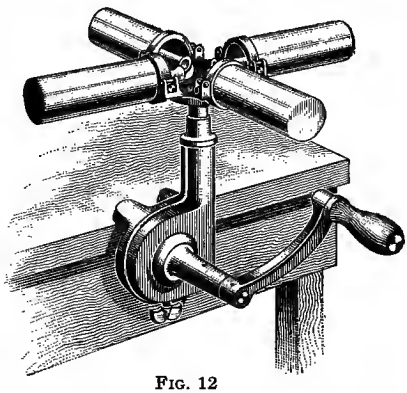


FIG. 12

to have the machine filled with bottles to balance it; in case but one sample of milk is to be tested the three other bottles can be filled with water. When the handle is turned, the chambers containing the bottles revolve around a common center and the centrifugal force that is exerted causes the bottles to assume the position shown in Fig. 12. The handle of the tester should be turned from 4 to 5 minutes at the speed given for the particular machine in use.

After the machine has stopped whirling the bottles will again assume a vertical position, and the fat will be found on top of the liquid. Enough hot water is then added to each bottle containing a sample to fill the bottle to the lower part of the neck; a pipette or some special device can be used for this purpose. The bottles are again placed in the tester and whirled for about 1 minute. After that they are taken out and hot water is added until the lower part of the column of fat comes up into the graduated neck of the bottle. The bottles are again placed in the tester and given a final whirl for about 1 minute. After the completion of the final whirl the bottles are removed and the percentage of fat is determined by means of the scale on the neck of the bottle.

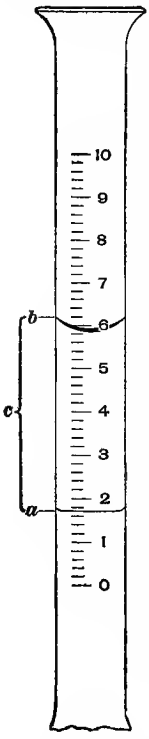


FIG. 13

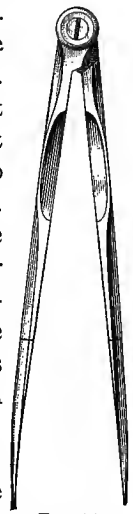


FIG. 14

13. For the testing of whole milk, a bottle with a scale arranged as shown in Fig. 13 is used. Each division represents .2 of 1 per cent. of fat; hence, each 5 divisions represents 1 per cent. of fat. The line of separation between the fat and the mixture of milk and acid is curved, as indicated at *a*. The top of the fat column also is curved, as shown at *b*. When ascertaining a percentage, the fat is measured from the lower part of the line *a* to the upper

part of the line *b*, as indicated by the brace *c*. In calculating a percentage, the reading indicated by the line *a* is subtracted from that indicated by the line *b*, and the result is the per cent. of fat in the milk. To avoid calculations, use is often made of a pair of dividers, such as that illustrated in Fig. 14. The points of the dividers are placed at the upper and lower lines of the fat column, and then lowered until one of the points reaches the zero mark of the scale. The upper point then marks the position on the scale that indicates the percentage of fat in the milk. In Fig. 13 the position of the lines *a* and *b* gives a reading of 4.5 per cent.

For the testing of cream and skim milk, different forms of bottles are required than for the testing of whole milk.

STANDARDS FOR MILK

MILK STANDARDS OF THE UNITED STATES

14. Government Milk Standards.—The United States government has comprehensive standards regarding the quality of the milk sold within its jurisdiction. These standards define the various kinds and forms of milk and establish certain requirements for them. The government standards of purity define milk as follows: Milk is the fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy cows, properly fed and kept, excluding that obtained within 15 days before and 10 days after calving, and contains not less than $8\frac{1}{2}$ per cent. of solids not fat, and not less than $3\frac{1}{4}$ per cent. of milk fat.

The government standards define cream as follows: Cream is that portion of milk, rich in milk fat, which rises to the surface of milk on standing, or is separated from it by centrifugal force, is fresh and clean, and contains not less than 18 per cent. of milk fat.

The milk standards of the government are merely a statement of the consensus of opinion of experts as to what the composition of milk should be. These standards are not in

TABLE III

STATE MILK AND CREAM STANDARDS

State	Milk			Cream
	Fat Per Cent.	Solids not Fat Per Cent.	Total Solids Per Cent.	Fat Per Cent.
Connecticut	3.25	8.50	11.75	
California	3.00	8.50		18
Georgia	3.25	8.50	12.00	18
Idaho	3.00	8.00	11.00	18
Illinois	3.00			15
Indiana	3.25	8.50		18
Iowa	3.00		12.50	15
Kentucky	3.25	8.50	12.00	18
Maine	3.00		12.00	
Maryland	3.50		12.50	
Massachusetts	3.25		12.15	15
Michigan	3.00		12.50	15
Minnesota	3.50		13.00	20
Missouri	3.25	8.50		18
Montana	3.00	9.00	12.00	15
Nebraska	3.00			18
New Hampshire	3.50	9.50	13.00	
New Jersey	3.00		12.00	16
New York	3.00		12.00	
North Carolina	3.25	8.50	12.00	18
North Dakota	3.00		12.00	15
Ohio	3.00		12.00	
Oregon	3.20	9.00	12.20	30
Pennsylvania	3.00		12.00	
South Dakota	3.00		13.00	18
Texas	3.00		12.50	
Utah	3.20	8.80	12.00	30
Vermont	4.00	9.25	12.50	
Virginia	3.25	8.50		18
Washington	3.00	8.00		
Wisconsin	3.00	8.50		18
Wyoming	2.40		12.00	

any law and have no legal standing, but in the trial of a case where milk was an article of interstate commerce and deficient in milk solids or in butter fat without evidence of actual adulteration, the federal standards representing the consensus of opinion of leading authorities would unquestionably be submitted as evidence in the case and have great weight.

15. State Milk Standards.—The majority of the states in the United States have legal standards for milk and cream sold within their borders. The state standards are different from those of the federal government in that they have the force of law. These standards, in many cases, are lower than the federal standards. There is a general movement in progress at the present time, however, among the various states whose milk standards are lower than those of the federal government, to raise the requirements for milk so that they will conform to the federal standards.

In Table III is given the legal standards for milk and cream of those states that have laws regarding the sale of milk.

16. From the table it may be seen that a majority of the states have similar standards and that, in general, these standards are similar to those of the United States. There are, however, a few exceptions. Vermont, with 4 per cent., has the highest fat standard for milk. Wyoming, with a fat standard of 2.4 per cent., is the lowest. Minnesota, New Hampshire, and South Dakota each require 13 per cent. of total solids. This means that the milk must have a fat content of about 4 per cent., as milk will seldom contain more than 9 per cent. of solids not fat. In Utah, to conform to the standard, cream must contain at least 30 per cent. of fat, which is high as compared with the cream standards of other states.

The milk sold by farmers or dairymen must conform to the standard of the state in which it is sold. If the fat standard of milk is 4 per cent. and the milk of a herd shows but 3.5 per cent. fat, the owner of the herd can, if he offers the milk for sale, be prosecuted for selling adulterated milk. The removal of any part of the cream or the addition of any foreign substance to milk or to cream is usually prohibited by

law. Consequently, if a farmer's cows produce milk with a fat content of 5 per cent. he cannot lawfully reduce the fat content to 4 per cent. by removing a part of the cream and adding skimmed milk to make up the bulk. The only legitimate way in which the quality of the milk can be lowered is to purchase cows that give milk of a lower fat content and mix their milk with that of the remainder of the herd.

Owing to the fact that New York and Wisconsin are two of the most important dairy states, extracts from their milk laws are quoted in the two succeeding articles.

17. Extracts From the Milk Laws of the State of New York.—The following are extracts from the milk laws of New York State:

The term *adulterated milk* means:

1. Milk containing more than 88 per cent. of water or fluids.
2. Milk containing less than 12 per cent. of milk solids.
3. Milk containing less than 3 per cent. of fat.
4. Milk drawn from cows within 15 days before or 5 days after calving.
5. Milk drawn from animals fed on distillery waste or any substance in a state of fermentation or of putrefaction, or on any unhealthful food.
6. Milk from cows kept in a crowded or otherwise unhealthful condition.
7. Milk from which any part of the cream has been removed.
8. Milk that has been diluted with water or any other fluids, or to which has been added or into which has been introduced any foreign substance whatever.

All adulterated milk shall be deemed unclean, unhealthful, impure, and unwholesome.

The terms pure milk or unadulterated milk, when used singly or together, mean sweet milk not adulterated.

The terms pure cream or unadulterated cream, when used singly or together, mean cream taken from pure and unadulterated milk.

The term adulterated cream, when used, shall mean cream that contains less than 18 per cent. of milk fat, or cream to which any substance whatever has been added.

No person shall keep cows for the production of milk for market, sale, or exchange, or for manufacturing the milk or cream from the same into any article of food, in a crowded or otherwise unhealthful condition, or feed any such cows on distillery waste or on any substance in a state of putrefaction or fermentation, or on any food

that is unhealthful, or that produces impure, unhealthful, diseased, or unwholesome milk. But this section shall not be construed to prohibit the feeding of silage.

All cans or other receptacles used in the sale of milk, cream, or curd for consumption as human food or in transporting or shipping the same to market, or for the delivery thereof to purchasers for consumption as human food, when found to be in an unfit condition to be so used, by reason of being worn out, badly rusted, or with rusted inside surfaces, or unclean or unsanitary, or in such a condition that they cannot be rendered clean and sanitary by washing, and will tend to produce or promote in milk, cream, or curd when contained therein, bad flavors, unclean, or unwholesome conditions favorable to unhealthfulness or disease, shall be condemned and cannot thereafter be used for milk, cream, or curd.

No person shall place in any can or other receptacle used for the handling of milk, any sweepings, refuse, dirt, litter, garbage, filth, or any other animal or vegetable substance liable to decay, and that tends to produce or promote an unsanitary condition.

The cans and other receptacles used for the handling of milk must be washed before they are returned to the producer.

18. Extracts From the Milk Laws of the State of Wisconsin.—The following are extracts from the milk laws of Wisconsin:

The term milk shall mean the fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy cows, properly fed and kept, excluding that obtained within 8 days before and 4 days after calving, and containing not less than 8½ per cent. of solids not fat, and not less than 3 per cent. of butter fat; and the term cream shall mean that portion of milk, rich in butter fat, which rises to the surface of milk on standing, or is separated from it by centrifugal force, is fresh and clean, and contains not less than 18 per cent. of butter fat.

Milk which shall be drawn from cows that are kept in barns or stables that are not reasonably well lighted and ventilated, or that are kept in barns or stables that are filthy from an accumulation of animal feces and excreta or from any other cause; or milk that shall be drawn from cows that are themselves in a filthy condition; or milk kept or transported in dirty, rusty, or open-seamed cans or other utensils; or milk that is stale, putrescent, or putrid; or milk to which has been added any unclean or unwholesome foreign substance; or milk which has been kept exposed to foul or noxious air or gases in barns occupied by animals, or kept exposed in dirty, foul, or unclean places or conditions, is hereby declared to be unsanitary milk.

Cream produced from any such aforesaid unsanitary milk; or cream produced by the use of a cream separator, which separator had not been thoroughly washed, cleansed, and scalded after previous use in the separation of cream from milk; or cream produced by the use of a cream separator placed or stationed in any unclean or filthy room or place or in any building containing a stable wherein are kept cattle or other animals, unless such cream separator is so separated and shielded by partition from the stable portion of such building as to be free from all foul or noxious air or gases which issue or may issue from such place or stable; or cream that is stale, putrescent, or putrid; or cream that is kept or transported in dirty, rusty, or open-seamed cans or other utensils; or cream which has been kept exposed to foul or noxious air or gases in barns occupied by animals, or in dirty, foul, or unclean places or conditions, is hereby declared to be unsanitary cream.

All premises and utensils used in the handling of milk, cream, and by-products of milk, and all premises and utensils used in the preparation, manufacture, or sale, or offering for sale of any food product for man from milk or cream or the by-products of milk, which shall be kept in an unclean, filthy, or noxious condition are hereby declared to be unsanitary. It shall be unlawful for any person, firm, or corporation engaged in selling or furnishing milk, cream, or any by-products of milk, intended for use as food for man; and it shall be unlawful for any person, firm, or corporation engaged in selling or furnishing milk, cream, or any by-product of milk to any creamery, cheese factory, milk-condensing factory, or to any place where such milk, cream, or by-products of milk are manufactured or prepared into a food product for man, and for sale as such; and it shall be unlawful for any milk dealer, or any employe of such milk dealer, or any person, or corporation, or the employe of such person, firm, or corporation, who operates a creamery, cheese factory, milk-condensing factory, or who manufactures or prepares for sale any article of food for man from milk, cream, or by-product of milk, or who manufactures, reworks, or packs butter for sale as a food product, to maintain his premises and utensils in an unsanitary condition.

Any person, firm, or corporation who receives in cans, bottles, or other vessels any milk, or cream, or other dairy product intended as food for man, which has been transported over any railroad or boat line or by other common carrier, when such cans, bottles, or vessels are to be returned, shall cause the said cans, bottles, or other vessels to be thoroughly washed and cleansed before return shipment.

Milk containing less than 3 per cent. of butter fat; or milk containing less than 8½ per cent. of milk solids not fat; or milk drawn from cows within 8 days before or 4 days after calving; or milk from which any part of the cream has been removed; or milk which has been diluted with water or any other fluid; or milk to which has been added

or into which has been introduced any coloring matter or chemical or preservatives or deleterious or filthy substance, or any foreign substance whatever; or milk drawn from cows kept in a filthy or unhealthy condition; or milk drawn from any sick or diseased cow, or cow having ulcers or other running sores; or milk drawn from cows fed unwholesome feed; or milk in any stage of putrefaction; or milk contaminated by being kept in stables containing cattle or other animals, shall be classed as adulterated milk.

Milk from cows fed on slops from distilleries or vinegar factories cannot be sold unless such refuse or slops are mixed with dry, sanitary grain or feed to the consistency of a thick mush.

19. City Milk Regulations.—Many cities, especially the larger ones, have rigid regulations regarding the quality of the milk sold within their limits and the manner of its production. With reference to the composition of milk, the standards of the cities are similar to those of the majority of the states. The question of the use of preservatives, however, is more important in the case of cities, as there is much temptation to use preservatives to keep surplus milk sweet from day to day; consequently, in most cities that have milk ordinances or regulations, especial attention is given to the matter of preservatives.

As has been previously stated, if milk is cooled well as soon as it is drawn from the cow, and is kept cold until it is delivered to the consumer, it will be much more desirable than if it has not been kept thus. To compel farmers and transportation companies to keep milk cold, many cities have adopted temperature standards and require that the milk sold within the city limits shall not be above the required temperature when it reaches the city, and that it is to be kept at a temperature no higher than the standard until it is delivered to the customer. If the temperature of the milk is found to exceed the standard temperature, such milk is returned to the shipper or is poured into the gutter. In New York, the temperature standard is 50° F.

20. The ideal condition with reference to the bacterial condition of milk is to have milk delivered to the consumer in the same condition, bacteriologically, as when it was drawn from the cow. This condition, of course, can only be approx-

imated, and in cases where the milk is shipped considerable distances, and is several hours old when it is delivered to the consumer, it is extremely difficult to control the bacterial condition. However, as the carelessness of the producer and the dealer shows in the number of bacteria in the milk, many cities have established bacterial standards for milk, and the sale of milk containing a greater number of bacteria than that of the standard is unlawful. Boston requires that milk shall contain not more than 500,000 bacteria per cubic centimeter; Rochester, New York, has a standard of 100,000 per cubic centimeter; Chicago allows 500,000 per cubic centimeter from October 1st to May 30th, and 1,000,000 per cubic centimeter during the other months of the year.

Samples of milk are collected and examined in laboratories established by the cities. If the milk from a particular farm shows an excess of bacteria in a number of successive examinations, the farmer is warned, and if subsequently the number does not become less, the milk is refused. Bacterial standards have been of much value in improving the quality of milk, as they have forced dairymen to improve their methods and equipment in order to produce milk that conforms to the standard.

It has been urged that bacterial standards for milk are unfair, as they do not take into account the kinds of bacteria present, but simply the number. It is true that milk may contain large numbers of bacteria, such as lactic-acid bacteria, and yet be perfectly healthful; buttermilk is a good example of such a condition. On the other hand, milk containing but few bacteria may be harmful. It should be remembered, however, that the consumer desires clean, healthful milk of good keeping qualities, and that lactic-acid bacteria, although harmless, are the ones that especially impair the keeping quality of milk.

21. Various other city regulations are generally made. Usually a license must be procured by each dealer or person selling milk. The applicant must state, in his application for a license, the source of the milk sold and the conditions

under which it is produced. The purpose of the license is to acquaint the health authorities with all persons selling milk in the city. Thus, the authorities are enabled to regulate, to some extent, conditions under which the milk is produced. Boston requires that all milk offered for sale within its city limits must be in tightly closed or capped bottles, or other receptacles. This provision practically does away with the sale of bulk milk in small stores, a manner of dispensing that has serious objections. Boston has rules, also, regarding the tasting of milk in order to determine its quality. A sterilized spoon or other similar utensil must be used for removing milk from cans or bottles for tasting, and the utensil must again be sterilized before it is used on a second can.

Some cities require that the tuberculin test be made on all animals that furnish milk for the city and that all tuberculous cows be removed from the herds. Chicago has such a provision, but in lieu of the test the milk may be pasteurized in accordance with the rules of the board of health. Certain cities require that milk shall not be shipped from any farm on which there is a case of typhoid fever, diphtheria, or scarlet fever until a permit stating that there is no danger of infection has been obtained from a physician. The farmer thus suffers a loss, as he may be forced to stop selling his milk for several weeks. For this reason, farmers are often tempted to conceal cases of contagious diseases. The most efficient manner of enforcing such regulations is to provide that the milk dealers pay the farmer for all milk held on the farm as a result of the presence there of a contagious disease. Under this condition there is no temptation for the farmer to conceal the disease. The cost to the consumer will be somewhat increased, as the milk dealer must have recompense for the milk paid for but not received. The consumer, therefore, must look at the additional cost as a premium on insurance against disease and thus should be willing to pay it. As it is possible for milk to become infected with typhoid baccilli at any point in its handling, milk dealers in cities having contagious-disease regulation are required to report all cases

that occur in the families of their employes. During the continuance of the disease in the family the employe is not allowed to have anything to do with the milk either directly or indirectly.

22. In cities, milk is examined in various ways to determine whether or not the producers and dealers are conforming to the regulations. The temperature of the milk may be taken either at the time of the arrival of the milk in the city or when it is delivered to the consumer. The presence of dirt is determined by noting the quantity of sediment in the bottles. Samples are taken for bacteriological and chemical analyses and for determining the presence of preservatives. The milk may also be examined microscopically in order to detect whether any of the animals are suffering from garget, a disease that will be explained in a subsequent Section. To control still further the manner of the production and handling of milk, the different farms, creameries, and city milk plants are inspected. In some cities, a score card on which are enumerated the various points to which the inspector must direct his attention, is used when an inspection of a dairy is made. To each item on the score card is given a certain number of points, the total of all points on the card amounting to 100. In scoring a dairy, the inspector makes a cut, or deduction, for each item listed on the card in which the dairy does not meet the standard. If the dairy is perfect in any item, the full number of points is given this item. The total of the points makes up the score of the dairy. The use of the score card for such work has proven valuable, as it brings to the attention of the farmer the points in which his equipment is deficient. Following is given the score card of the city of New York. Score cards of other cities are similar, about the only difference being in the number of points given to each item.

DEPARTMENT OF HEALTH

THE CITY OF NEW YORK

Division of General Sanitary Inspection — Dairy Report

Inspection No.....Time.....A. P. M. Date.....191..

1 Dairyman..... Owner.....

2 P. O. Address..... P. O. Address.....State.....

3 County.....State..... Party Interviewed.....

4 Milk delivered to Creamery at.....Formerly at.....

5 Operated by.....Address.....

6 Distance of farm from Creamery.....Occupied farm since.....

7 No. Cows.....No. Milking.....No. Qts. Produced.....

8 All persons in the households of those engaged in producing or handling milk are.....free from all infectious disease. Weekly reports are.....being filed.....

9 Date and nature of last case on farm.....

10 Water supply for utensils is from a.....located..... feet deep and apparently is.....pure and wholesome..... State any possible contamination located within 200 feet of source of water supply or if water supply is not protected against surface drainage.....

.....

.....

11 Water supply on this farm analyzed.....191.. Result.....

12 Style of Cow Barn.....Length....ft. Width....ft. Height of ceiling.....ft.

13 Dairy Rules of the Department of Health are.....posted.....

14 Dairy Herd examined by.....on.....191.. Report.....

		Perfect	Allow
	EQUIPMENT		
15	Cow stable is....located on elevated ground with no stagnant water, hog pen, privy, uncovered cesspool, or manure pit within 100 feet.....	1	.....
16	Floors, other than cow beds, are.....of concrete or some non-absorbent material.....	2	.....
17	Floors are.....properly graded and watertight.....	2	.....
18	Cow beds are....of concrete or planks laid on concrete.....	2	.....
19	Drops are....constructed of concrete, stone, or some non-absorbent material.....	2	.....

		Perfect	Allow
	EQUIPMENT—(*Continued*)		
20	Drops are.....water-tight and space beneath is clean and dry.....	2	.....
21	Ceiling is constructed of.....and is....tight and dust-proof.....	2	.....
22	Windows No.....total square feet....there is.....2 square feet of window light for each 600 cu. ft. air space (1 sq. ft. per each 600 cu. ft. −1).....	2	.....
23	Ventilation consists of....sq. ft. muslin covered openings or....sq. ft. open chutes in ceiling, or.....which is sufficient 3, fair 2, poor 1, insufficient 0.....	3	.....
24	Air space is....cu. ft. per cow (600 and over—3) (500 to 600—2) (400 to 500—1) (under 400—0).....	3	.....
25	Livestock, other than cows, are....excluded from rooms in which milch cows are kept...	2	.....
26	There is.....direct opening from stable into silo or grain pit.....	1	.....
27	Separate quarters are.....provided for cows when calving or sick.....	1	.....
28	Cow yard is....properly graded and drained..	2	.....
29	Water supply for cows is .....unpolluted and plentiful.....	1	.....
30	Milk house has.....direct opening into cow barn or other building.....	1	.....
31	Milk house has....sufficient light and ventilation.....	1	.....
32	Floor is....properly graded and water-tight..	1	.....
33	Milk house is....properly screened to exclude flies.....	1	.....
34	Milk pails are.....of smoothly tinned metal in good repair.....	1	.....
35	Milk pails have....all seams soldered flush...	2	.....
36	Milk pails are.....of the small mouthed design, top opening not exceeding 8 inches in diameter; diameter.....	2	.....
37	Racks are.....provided to hold milk pails and cans when not in use.....	2	.....
38	Special milking suits are.....provided.....	1	.....

		Perfect	Allow
	METHODS		
39	Stable interior painted or whitewashed on.... ....which is satisfactory 3, fair 2, unsatisfactory 1, never 0.....	3	.....
40	Feeding troughs, platforms or cribs are..... .....well lighted and clean.....	1	.....
41	Ceiling is.....free from hanging straw, dirt, or cobwebs.....	3	.....
42	Window panes are .... washed and kept clean.....	1	.....
43	Walls and ledges are.....free from dirt, dust, manure, or cobwebs.....	2	.....
44	Floors and premises are.....free from dirt, rubbish, or decayed animal or vegetable matter.....	2	.....
45	Cow beds are.....clean, dry, and no horse manure used thereon.....	2	.....
46	Manure is.....removed to field daily 4, to at least 100 feet from barn 2, stored less than 100 feet or where cows can get at it 0.....	4	.....
47	Liquid matter is.....allowed to saturate ground under or around cow barn.....	2	.....
48	Milking stools are.....clean.....	1	.....
49	Cow yard is.....clean and free from manure..	2	.....
50	Cows have.....been tuberculin tested and all tuberculous cows removed.....	7	.....
51	Cows are.....all in good flesh and condition at time of inspection.....	2	.....
52	Cows are.....all free from clinging manure and dirt. (No. dirty.....).....	4	.....
53	Long hairs are.....kept short on belly, flanks, udder, and tail.....	1	.....
54	Udder and teats of cows are.....thoroughly brushed and wiped with a clean damp cloth before milking.....	3	.....
55	All feed is.....of good quality and distillery waste or any substance in a state of putrefaction is.....fed.....	2	.....
56	Milking is.....done with dry hands.....	2	.....
57	Fore milk, or first few streams from each teat, is.....discarded.....	2	.....
58	Clothing of milkers is.....clean.....	1	.....

		Perfect	Allow
	METHODS—(*Continued*)		
59	Facilities for washing hands of milkers are .....provided in cow barn or milk house..	2	.....
60	Milk is strained at.....and.....in clean atmosphere.....	1	.....
61	Milk is.....cooled within two hours after milking to 50° F. 3, to 55° F. 2, to 60° F. 1..	3	.....
62	Ice is.....used for cooling milk.....	1	.....
63	Milk house is.....free from all dirt, rubbish, and material not used in the handling and storage of milk.....	1	.....
64	Milk utensils are.....rinsed with cold water immediately after using and washed clean with hot water and washing solution.....	2	.....
65	Utensils are.....sterilized by steam or boiling water after each using.....	2	.....
66	Privy is.....in sanitary condition, with vault and seats.....covered and protected....	1	.....

Remarks—

Equipment, 40 per cent. Score .....per cent.
Methods, 60 per cent. Score .....per cent.
Perfect dairy, 100 per cent. Score.....per cent.

23. Many cities provide for the sale of several grades of milk, and laws are made naming the standard to which each grade shall conform. The following is the milk classification used in the city of New York:

The term market milk is applied to milk that conforms to the state law, but does not meet the requirements of milk sold under other grades.

Selected milk is that produced under the following conditions: Only such cows shall be admitted to a herd producing selected milk as are free from all diseases of the udder, and from clinically-manifested tuberculosis, that is, no physical symptoms of the disease are to be apparent; all cows shall be examined clinically each year by a veterinarian of the department of health; all cows with any disease of the udder or with clinically-manifested tuberculosis are to be excluded from the herd and farm. The milk in winter shall contain not more than 60,000 bacteria per cubic centimeter and in summer not more than 100,000 per cubic entimeter; the milk must be deliv-

ered to the consumer only in sealed bottles that have been filled at the dairy or creamery and that have been labeled with the date of milking of the oldest milk that forms a part of the contents of the bottle; the milk must be delivered within 36 hours after milking.

Guaranteed milk is that of which the minimum requirements are as follows: The cows shall be free from tuberculosis as shown by the tuberculin test; they must be tested annually and all diseased animals excluded from the herd. The milk must not contain more than 30,000 bacteria per cubic centimeter when delivered to the consumer. The requirements as to dating and delivering are the same as for selected milk.

Milk known as pasteurized milk must be heated in accordance with the official schedule. It must be delivered to the consumer in sealed containers that are labeled "Pasteurized," with the date and hour when pasteurized, the degree of heat employed, the length of time exposed to heat, and the number of the pasteurization permit issued by the department of health. Pasteurized milk must be delivered to the consumer within 24 hours after pasteurization, and no milk may be pasteurized a second time.

Certified milk is that produced under the direction and which conforms to the regulations of a milk commission appointed by a county medical society organized under and chartered by the medical society of the state of New York.

The milk commission adopts rules and regulations concerning the production of milk that shall be entitled to receive the certificate of the commission. The producer who wishes to have his milk certified must satisfy the commission that he can conform to their rules in all respects. The rules of the commission are very stringent and cover the points that may have influence on the value of milk for human food. The number of bacteria allowed is usually 10,000 per cubic centimeter. The commission employs experts to aid in the examination of the milk and in the inspection of the dairies. These experts are usually bacteriologists, chemists, veterinarians, or physicians, whose duties are to examine the cattle, the surroundings with which the milk comes in contact, the milk itself, and the personnel of the dairy. Certified milk is largely produced on farms having expensive equipment, although it can be produced with very simple equipment and with much less expense than is often supposed. Certified milk sells for from 12 to 25 cents per quart.

MILK STANDARDS OF CANADA

24. Following are given the milk standards of Canada as published by the Canadian Department of Inland Revenue. It can be seen that in many respects they are similar to those of the United States.

Milk, unless otherwise specified, is the fresh, clean, and unaltered product obtained by the complete, uninterrupted milking, under proper sanitary conditions, of one or more healthy cows, properly fed and kept, excluding that obtained within two weeks before and one week after calving, and contains not less than 3¼ per cent. of milk fat, and not less than 8½ per cent. of milk solids other than fat.

Skim milk is milk from which a part or all the cream has been removed, and contains not less than 8½ per cent. of non-fat milk solids.

Pasteurized milk is milk that has been heated below boiling, but sufficiently to kill most of the active organisms present; and immediately cooled to 45° F., or lower, and kept at a temperature not higher than 45° F. until delivered to the consumer, at which time it shall contain not more than 10,000 bacteria per cubic centimeter.

Sterilized milk is milk that has been heated at the temperature of boiling water, or higher, for a length of time sufficient to kill all organisms present; and must be delivered to the consumer in a sterile condition. Sterilized milk shall not be sold or offered for sale, except in hermetically-closed containers bearing the words "This milk should be used within 12 hours after opening the container."

Certified* milk, sold as such, shall comply with the following requirements:

1. It shall be taken from cows semiannually subjected to the tuberculin test, and found without reaction.
2. It shall contain not more than 10,000 bacteria per cubic centimeter from June to September; and not more than 5,000 bacteria per cubic centimeter from October to May, inclusive.
3. It shall be free from blood, pus, or disease-producing organisms.
4. It shall be free from disagreeable odor or taste.
5. It shall have undergone no pasteurization or sterilization, and shall be free from chemical preservatives.
6. It shall have been cooled to 45° F. within half an hour after milking, and kept at that temperature until delivered to the consumer.
7. It shall contain 12 to 13 per cent. of milk solids, of which at least 3½ per cent. is fat.

* It is evident that the weight carried by the term "certified" will depend upon the character of the organization that assumes responsibility. Doubtless this will usually be a local medical association; but there is nothing to prevent any responsible body of properly qualified persons from undertaking the production of certified milk.

8. It shall be from a farm whose herd is inspected by a veterinarian, and whose employes are examined monthly by a physiican.

Evaporated milk is milk from which a considerable portion of water has been evaporated, and contains not less than 26 per cent. of milk solids, and not less than $7\frac{1}{5}$ per cent. of milk fat.

Condensed milk is milk from which a considerable portion of water has been evaporated and to which sugar has been added. It contains not less than 28 per cent. of milk solids, and not less than $7\frac{7}{10}$ per cent. of milk fat.

Condensed skim milk is skim milk from which a considerable portion of water has been evaporated, with or without the addition of sugar.

Buttermilk is the product that remains when butter is separated from ripened cream, by the usual churning processes; or a similar product, made by the appropriate treatment of skim milk.

Goat's milk, ewe's milk, etc., are the fresh, clean, lacteal secretions, free from colostrum, obtained by the complete milking of healthy animals other than cows, properly fed and kept, and conform in name to the species of animals from which they are obtained.

Cream is that portion of milk, rich in milk fat, which rises to the surface of milk on standing, or is separated from it by centrifugal force, is fresh and clean, and contains (unless otherwise specified) not less than 18 per cent. of milk fat. When cream is guaranteed to contain another percentage of milk fat than 18 per cent., it must conform to such guarantee. Cream must be entirely free from gelatine, sucrate of lime, gums, or other substances added with a view to give density, consistency, or apparent thickness to the article. Cream must contain no preservatives of any kind, nor any coloring matter other than is natural to milk.

Evaporated cream, clotted cream, condensed cream, or any other preparation purporting to be a special cream, except ice cream, must conform to the definition of cream, and must contain at least 25 per cent. of milk fat.

HANDLING OF MARKET MILK

25. Milk Cans and Their Care.—If cans are used for the handling of milk, they should be of heavy tin and reinforced at the top and bottom with heavy metal bands. The openings of the cans should be large enough to permit of easy washing of the interior; the inner surface should be bright; all seams should be well flushed with solder; and there should be no sharp angles. Dented cans should be discarded, as they are difficult to keep clean.

Cans vary considerably in style, and the farmer should try to obtain a style that is provided with a cover that will shield the top of the can from dust and dirt. In Fig. 15 are shown four styles of milk cans. The style shown in (*a*) is the New York can; in (*b*), the Iowa can; in (*c*), the Philadelphia can; and in (*d*), the so-called factory can. The New York can is preferable, as the cover *a* tends to exclude foreign matter from the can. The Iowa and Philadelphia cans are less desirable on account of the likelihood of dirt getting into the interior. The style of can shown in (*d*) is especially undesirable, as the cover *b* fits into the top of the can and hence the surface at *c* is exposed to dust and dirt.

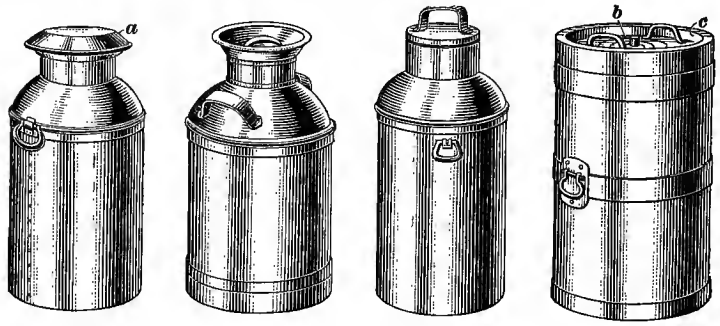


FIG. 15

26. In filling cans that are to be transported even a short distance, it is important that no space be left between the top of the milk and the cover; in other words, the cans should be filled full. Unless this precaution is observed, it is likely that partial churning may occur and particles of butter will be formed that cannot be reincorporated in the milk. If the wagon that is used for transporting the filled cans is not provided with a top, the cans should be covered in some way to exclude dust and to protect them from the heat of the sun. Either a canvas that covers the entire load, or separate felt covers for each can may be used. A desirable form of felt can cover is illustrated in Fig. 16. This cover is provided with straps and buckles for fastening it in place, and may be easily and quickly put on the can.

Milk cans should be thoroughly washed and dried before they are returned to the farmer, and all milk plants should be provided with facilities for such work. Large can washers are made that have revolving brushes for cleaning both the interior and the exterior of the can. After the cans have been thoroughly brushed they may be placed on some such apparatus as the one illustrated in Fig. 17, which, depending

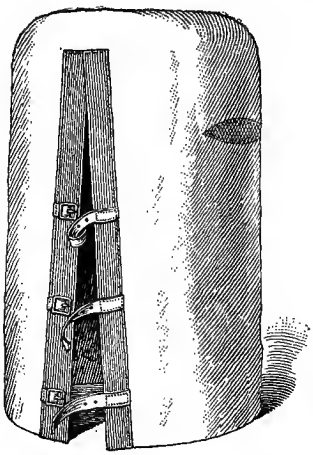


FIG. 16

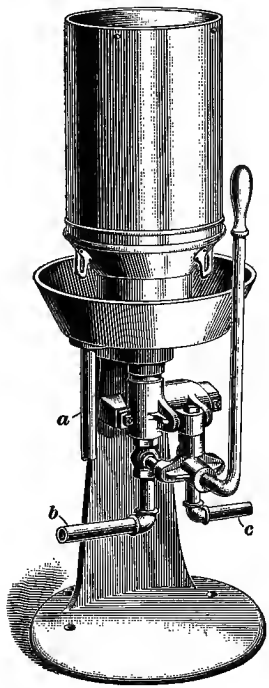


FIG. 17

on the position of the handle, will deliver into the can either jets of cold water, a mixture of steam and water, or steam alone. Pipe *a* is the drain pipe through which water runs after passing into the can; pipe *b*, the steam pipe; and pipe *c*, the water-supply pipe. Similar types of apparatus are arranged so that hot, dry air may be passed into the can to dry it thoroughly. A can that has been thoroughly cleansed and then dried will be in good condition when it reaches the

farm, but a can in which a little water remains will often have a musty, disagreeable odor, especially in hot weather.

27. Milk Bottles, Caps, and Filling Utensils.—Farmers often use the forms of milk bottles shown in Fig. 18 for the delivering of milk. The same general style of bottle is used in all parts of the United States, but the bottles vary greatly in form. Milk and cream bottles are made in ¼-pint, ½-pint,

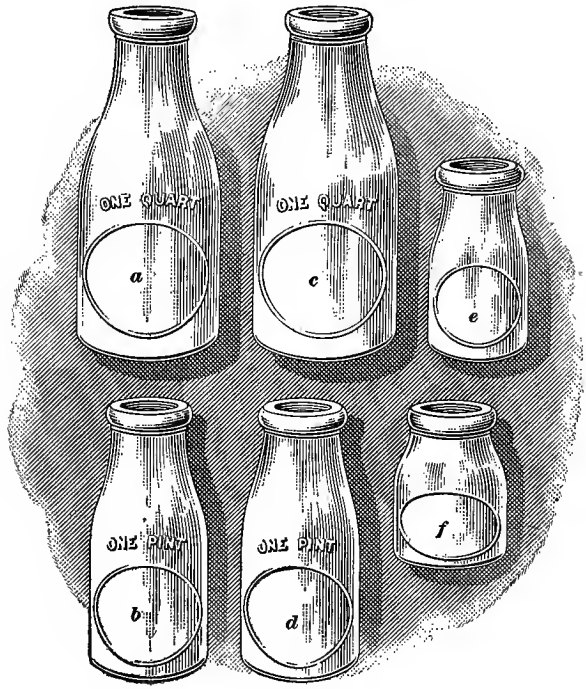


FIG. 18

1-pint, 1-quart, and 2-quart sizes. All bottles should be of clear glass of uniform thickness, and be well annealed, as this process largely prevents glass from cracking when exposed to sudden changes in temperature. Quart and pint bottles used for milk are generally made of a form to show a good depth of cream. The quart bottle *a* and pint bottle *b* in Fig. 18 have rather narrow necks; bottles of this form will

show a comparatively large depth of cream. The quart bottle *c* and the pint bottle *d* have wide necks and will show a smaller depth of cream. Bottles *e* and *f* are for cream. Bottles used for cream are made with rather wide necks. As a rule, dealers have their names blown on all the bottles they use. Although this prevents the loss of many bottles, it makes them more difficult to clean, for dirt that lodges between the letters is difficult to remove.

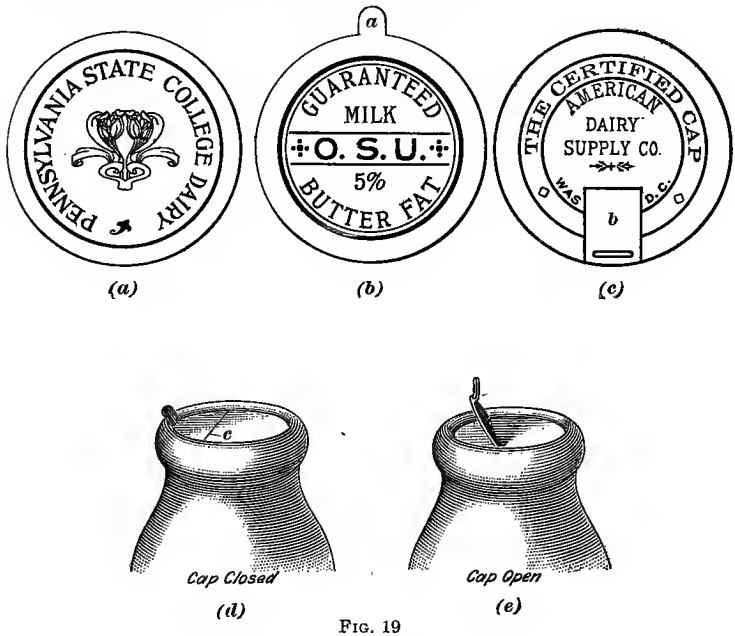


FIG. 19

28. For the covering of milk bottles, pulp caps are used. They should be paraffined to prevent them from becoming water-soaked. A few of the different styles of caps on the market are illustrated in Fig. 19. The plain cap shown in (*a*) is probably the most widely used. One objection to this style of cap is that a fork or some such sharp instrument must be used to remove it from the bottle. As a result, a small quantity of cream may be spilled or dirt may get into the bottle. Several caps have been devised to obviate this

difficulty. In (*b*) is shown the so-called flipper cap. This style gets its name from the projection *a*, which remains vertical when the cap is in place on the bottle. This projection provides a convenient means of removing the cap, and, in addition, the cap can be removed without disturbing the cream. One disadvantage of the flipper style of cap is that leakage is likely to occur, as the projection prevents a perfect closure of the bottle at the point where the projection is attached. In (*c*) is shown a style of cap that is an improvement over the flipper style. A small oblong piece of tough paper *b* is attached to the cap by means of a wire staple. This piece of paper takes the place of the projection of the flipper style. As this cap makes a perfect closure of the bottle, there is no leakage of cream. In (*d*)

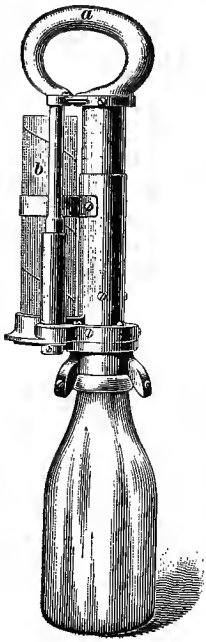


FIG. 20

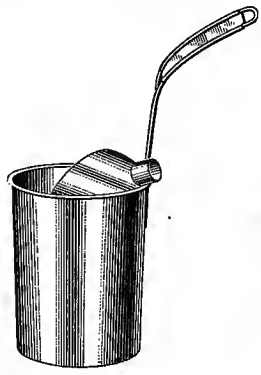


FIG. 21

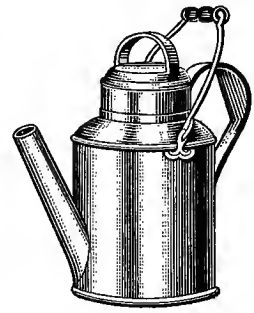


FIG. 22

is illustrated a style of cap that can be opened and milk poured from the bottle without removing the cap. The cap is scored at *c*, which permits a lifting of a part of the cap as shown in (*e*). The lift tab is arranged so that there is a perfect closure of the bottle when the flap is down.

It is a good plan for a dairyman to have his or his firm name printed on the caps as shown in the illustration, and where there is a special feature, as for example, a guaranteed

percentage of butter fat in the milk, this should appear on the cap as shown in Fig. 19 (*b*). Caps for dairy bottles can be obtained from dairy supply houses in tubes in which they have been sterilized. From these tubes they can be rapidly placed in the bottles by hand.

There are on the market several mechanical devices for capping bottles. In Fig. 20 is illustrated a small, single-bottle capper that is useful for a farmer having only a few bottles to cap. The device has a handle *a* for operating it and a magazine *b* for holding a number of caps. A slight pressure on the handle places a cap on the bottle and another in position ready for capping the next bottle.

FIG. 23

29. Various devices for the filling of milk bottles may be purchased from dealers in dairy supplies. In Fig. 21 is illustrated what is known as a milk dipper, and in Fig. 22 is illustrated a milk kettle. These simple devices are much used by dairymen who have only a small number of bottles to fill at one time. In Figs. 23 and 24 are shown two styles of mechanical bottlers. The style illustrated in Fig. 23 is known as the single-bottle filler. The milk is placed in the

can *a* and by a downward pressure on this the bottle is filled. The style of filler shown in Fig. 24 is called a two-valve filler. It is operated by means of the lever *a*. When a large number of bottles are to be filled, use is made of automatic devices that have capacities of several thousand bottles per hour each.

30. Bottles used for the handling of milk should be thoroughly washed when they become empty. To do this, brushes that can be inserted into the bottle are necessary.

Use is made also of washing powder, hot

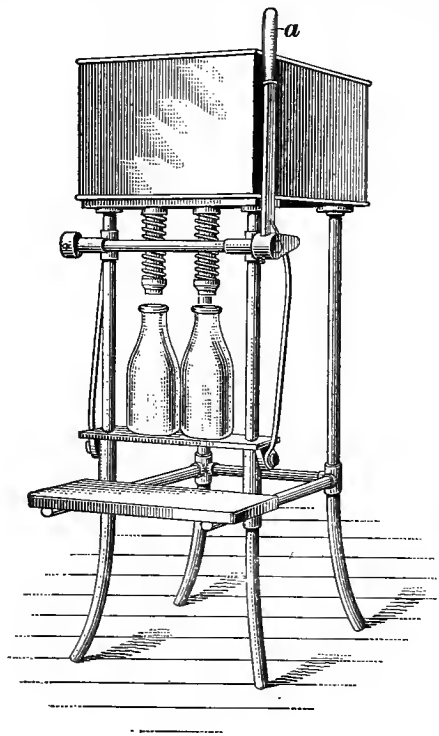


Fig. 24

Fig. 25

and cold water, and, when available, steam. The hot water or the steam is for sterilizing the bottles to prevent bacterial growth. When only a small number of bottles are to be washed, a brush similar to the one illustrated in Fig. 25 is used. When a large number are to be cleansed, a more convenient means

than the hand brush should be provided, not only on account of the saving in time but because the work can be done easier,

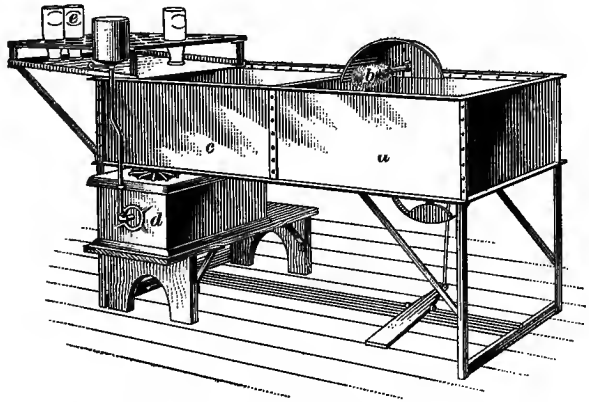


FIG. 26

and therefore is likely to be done better. In Fig. 26 is shown a two-compartment metal tank that is convenient for washing

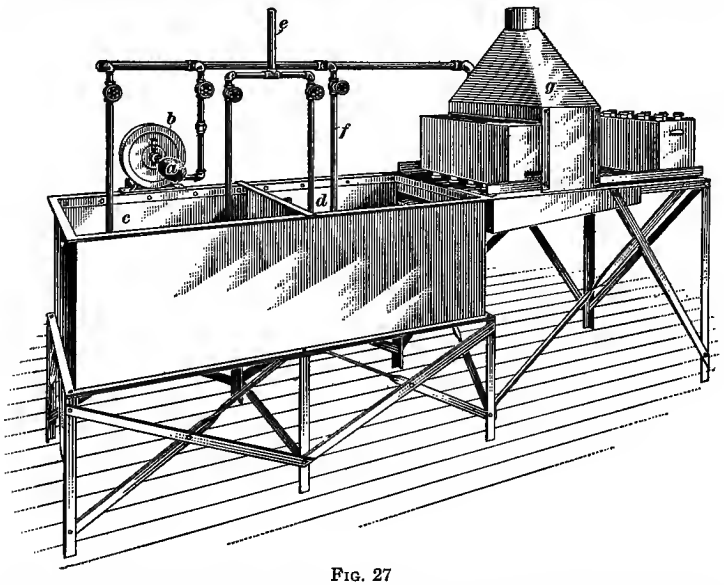


FIG. 27

a large number of bottles. The tank *a* is for holding cold or slightly warm water to which is added a quantity of washing

powder. The bottles to be washed are partly filled with water from this tank, slipped, one at a time, over the brush *b*, which is revolved by foot power applied by means of the treadle, and are then placed in clean hot water in tank *c*, which is heated by means of a small gasoline stove *d*. After being rinsed thoroughly, the bottles should be placed in an inverted position on draining boards as shown at *e*.

In Fig. 27 is shown a convenient arrangement for the washing of bottles where steam is available. The brush *a* is operated by a steam turbine *b*. The wash water is held in the tank *c* and the rinsing water in tank *d*. The cold water for the tanks comes from the water-supply pipe *e*. The water in tank *d* is heated to the temperature desired by steam that passes through the steam pipe *f*. It is not necessary that this water be kept boiling, for, after being rinsed in hot water, the bottles are sterilized by jets of steam in the chamber *g*.

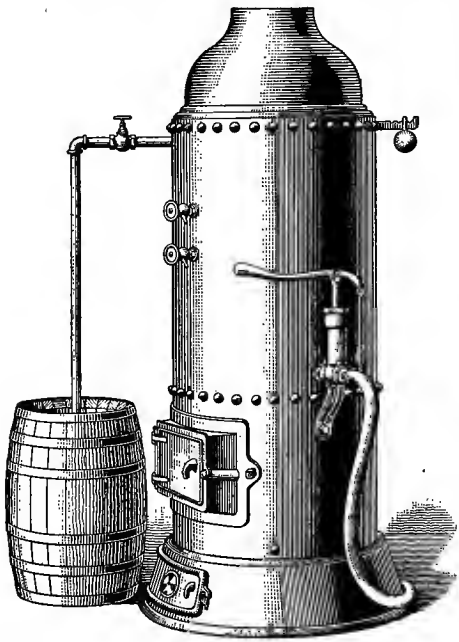


FIG. 28

31. Steam Boilers.—Where a large quantity of milk is handled, it is a good plan to have a boiler of some kind in the dairy building. Steam is useful not only for furnishing power to run the dairy machinery, but also for sterilizing the equipment. Fig. 28 shows a type of boiler suitable for a dairy house. Boilers like the one illustrated, or similar, can be purchased from dairy supply houses.

FARM BUTTER MAKING

INTRODUCTION

1. Coincident with the development of shipping facilities in country communities and the establishment and growth in popular favor of commercial creameries, cheese factories, and milk condenseries as markets for milk, there has been a notable decrease in the practice of making butter on farms. The development of shipping facilities has widened the shipping zones surrounding cities and thus has made it possible for milk, even from many remote localities, to be transported to city markets for consumption as whole milk. Creameries, cheese factories, and condenseries are important markets for milk, as they are numerous, are located, in many sections, so as to be easily accessible to a large number of farmers, and usually pay fairly good prices. Due to the fact that, as a rule, the making of butter on farms is the least profitable method of disposing of milk, the practice has lost in popular favor to the extent that in many localities it has practically become obsolete.

Although the practice of farm butter making is decreasing, there are conditions under which it might be of advantage to utilize milk for this purpose. For instance, if a farm is located at a considerable distance from a milk market and the transportation of the milk to market is difficult or costly, it will probably be more profitable to make butter than to sell the milk. Also, if a farmer has a herd of cows that produce exceptionally rich milk, he will, as a rule, find it

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ENTERED AT STATIONERS' HALL, LONDON

more profitable to make butter than to sell the milk, unless a special price can be obtained for the latter. Still another condition under which it might be advisable to make butter from the milk is when but a few cows are kept on a farm and the quantity of milk that is produced is not sufficient to justify the trouble and cost of transporting it to market. Again, it often happens that the dairyman desires to make butter for home use, and in this case it is but little more trouble to make a few extra pounds for local sale. In addition to these reasons, many farmers prefer to make butter because they can use the skim milk and buttermilk as feed for calves, swine, and chickens. Another reason for many farmers preferring to make butter is that the selling of milk often necessitates extremely early rising and various other details of routine that are objectionable. From these statements it can be seen that the advisability of making butter on the farm is largely dependent on local conditions and on the personal preference of the dairyman.

2. In the making of butter on farms, one of the fundamental requirements is to perform the various operations under sanitary conditions. The farm butter maker is not likely to be provided with equipment such as is used by commercial creameries, or to be able, for economic reasons, to practice the same methods; therefore, he is unable to overcome, to the same degree, the ill effects of a lack of care in the handling of milk and cream. The secret of success in making good butter on farms is to protect the milk and cream from contamination from the time the milk is drawn until the cream is churned. The sanitary production and handling of milk has already been discussed in *Milk*, Part 1, and the principles set forth in that Section should be rigidly observed in the making of butter on farms.

It is difficult to give specific instruction relative to the equipment that is required for farm butter making, because of the wide range in the quantity of butter that is made on different farms. In the following pages considerable space is devoted to the illustration and description of equipment

in order to give an idea of the advantages and disadvantages of the various kinds of quarters and devices that are in use. It should not be inferred that all or any particular part of the equipment described is absolutely necessary to the making of butter.

EQUIPMENT FOR FARM BUTTER MAKING

QUARTERS

3. In the making of butter on farms, it is necessary to have suitable quarters in which to perform the various operations, if a good quality of butter is to be produced. As milk, cream, and butter are very susceptible to contamination, the quarters should be such as to exclude, as far as possible, all foreign matter and objectionable odors. In addition, it is desirable that they should possess some degree of convenience. The conveniences provided will, of course, depend largely on the amount of money that the butter maker is willing to expend in fitting them up, and this, in turn, will probably be governed by the quantity of butter that is produced or that is likely to be produced in the future. It is important, also, that there should be adequate facilities for keeping the milk, cream, and butter at the proper temperatures. It is likely that on most farms the temperature of these products will be regulated by means of water; in some cases ice and steam may be available for the purpose. Where water is used for controlling the temperature, it will be practically necessary, of course, either to have the quarters located near the water supply or to pipe the water to the quarters.

In locating the butter-making quarters, much consideration should be given, also, to the matter of their proximity to the dwelling and to the dairy barn. As butter making is a routine matter and the operations must be carried on during all kinds of weather, it is desirable that the quarters should not be too far distant from either of these buildings. On the other hand, it is possible to have the dairy barn and butter-

making quarters so near to the dwelling that odors from the two former will permeate the latter.

The quarters that are the most suitable for use in farm butter making may be classed as five kinds; namely, rooms in dwellings, cellars, caves, spring houses, and special buildings. The general requirements, advantages, and disadvantages of each kind are discussed in the following pages.

4. Rooms in Dwellings as Butter-Making Quarters.—On farms where butter is made in comparatively small quantities, such as where churning is done but two or three times each week, a room or rooms in the dwelling can often be utilized as the butter-making quarters. As a rule, it will be more economical to use a room in the dwelling than to provide a special building. An advantage of a room in a dwelling is that it is more accessible than a separate building, no matter how near to the house the latter may be. A disadvantage of using a room in a residence for the butter-making quarters is that disagreeable odors are likely to permeate the living rooms from the dairy quarters, and another is that odors from the living rooms may enter the dairy quarters and contaminate the milk, cream, and butter.

A room that is used for butter making should be light, clean, well ventilated, and have tight walls to exclude dust and odors. It should be large enough to afford adequate space for the various operations, be equipped with as many conveniences as possible, and be located well to the rear of the house and on the side toward the prevailing wind, so that odors from the living rooms will blow in the opposite direction from the butter-making quarters.

It is the custom, on many farms, to ripen cream and to churn in the kitchen of the farm residence. This practice is decidedly unfavorable to the production of good butter. Cream, in setting behind a kitchen stove for several hours during the ripening process, and later when being thoroughly stirred by the churning, readily absorbs odors from food that is being cooked, and these odors are imparted to the butter.

5. Cellars as Butter-Making Quarters.—When butter is made on a limited scale, a large, roomy cellar affords a desirable place in which to perform either a part or all of the operations. The temperature in a cellar can usually be regulated to a reasonable degree of uniformity throughout the year, and this not only facilitates the proper handling of the milk, cream, and butter, but adds to the comfort of the butter maker. The greatest disadvantage of a cellar as a place in which to make butter is that much extra work is required in going up and down the cellar steps.

If the cellar is used for other purposes, such as for the storing of vegetables, a part of it should be partitioned off by a tight wall to exclude dust and odors, and this part used solely as the butter-making quarters. A sufficient number of windows to furnish abundant light and ventilation should be provided. The windows should be hinged so that they can be opened, and it is advisable to provide screens to keep out insects and coarse dust. The floor should be hard, dry, and free from cracks or crevices; if the floor is smooth, less work will be required to keep it clean than if it is rough. Clay, if well tamped, brick, stone, or lime-and-sand mortar may be used, but a floor made of any of these materials will not be as desirable as a smooth, well-laid cement floor, because such a floor can be easily kept clean. The walls and the ceiling should be smooth and tightly constructed. The door should be smooth and solid and fit tightly in the casing. It is advisable to paint the walls and ceiling occasionally with a light-colored paint to aid in making the room light and clean. Whitewash should not be used, as it scales off and may fall into the milk or butter. If about ½ bushel of air-slaked lime is kept in a tub or box in some part of the dairy cellar where it will be out of the way, any excess of moisture that may collect will be absorbed by the lime. This is particularly helpful in the summer months, especially in August.

6. Caves as Butter-Making Quarters.—In case neither a special room in the dwelling nor a cellar is available as quarters for the making of butter, it may be desirable to make a cave

for this purpose. Caves that are properly constructed have the advantage of affording a comparatively uniform temperature throughout the year, and of being practically free from influences that would tend to contaminate the milk, cream, and butter. Caves are often somewhat inconvenient in that, as a rule, water must be carried into them in pails, although it is possible, of course, to overcome this objection by piping the water.

The depth to which the excavation is made will depend on the size that it is desired to make the cave and on the character of the soil. In loose, well-drained soils, a cave 15 feet long, from 12 to 15 feet wide, and deep enough to give a space of from about 7 to 9 feet from floor to ceiling, can be dug without much difficulty and will afford ample room for the butter-making operations, provided the business is not conducted on too large a scale. The walls of the cave may be constructed of stone or brick, but cement will usually be found more satisfactory for this purpose. If the cave is built on a hillside the walls should extend from the floor to a foot or more above the surface of the ground at the highest point on the slope, and, of course, considerably higher at the lowest point, which will be at the entrance. The walls can be arched over above ground with the same material used below ground. Some form of window or windows should be placed in the arch to provide light and ventilation. The floors can be made similar to those recommended for cellars.

7. Spring Houses as Butter-Making Quarters.—During summer, or in localities where the weather is warm or mild throughout the year, there is no more desirable place in which to make butter than in a spring house, which is a building that is built over a spring, or so near to one that the spring water runs directly through the house. The chief point of advantage in such a building is that usually a constant supply of cold water is available, and hence it is possible to keep the milk, cream, and butter at a low temperature. Of course, all farms do not have springs available for such use, but where possible a spring should be utilized.

Owing to the fact that spring houses are constantly subjected to dampness, it is advisable to construct them of some material that does not decay. Stone, bricks, or cement will prove satisfactory for this purpose. There should be several windows in the sides to provide light and ventilation, as the damp air rising from the flowing water affords a favorable environment for the growth of bacteria and molds. The floor can be made of brick, stone, or cement, the latter being preferable.

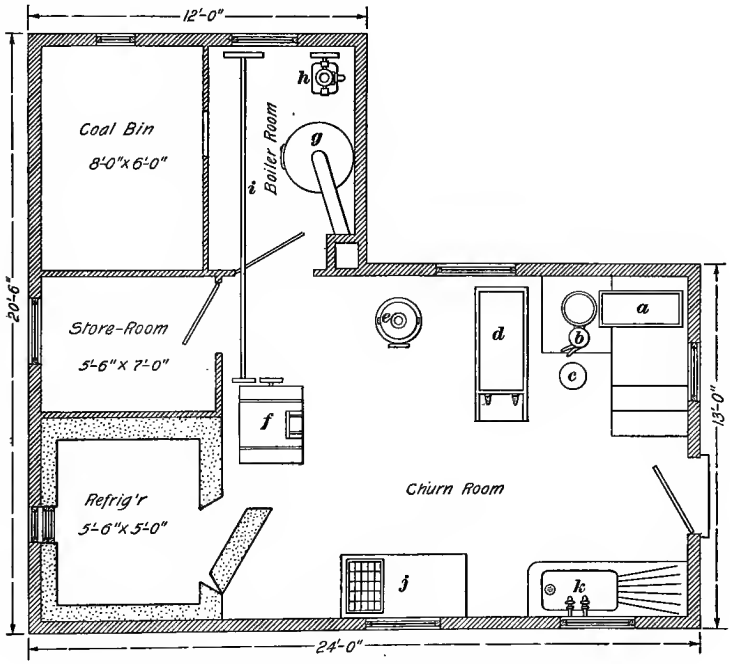


FIG. 1

8. Special Buildings as Butter-Making Quarters.—On farms where large quantities of butter are made and such quarters as have already been described are inadequate for the purpose, it will be necessary to provide a special building. The exact size and equipment of such a building must, of course, be governed by the extent of the business. It is desirable that the building be located near the dairy barn in

order to save labor in carrying the milk. If butter is being made in sufficient quantities to justify the use of a special building, it is practically necessary that water be piped into the building.

In Fig. 1 is shown a floor plan of a special building for butter making on a farm where 20 cows or more are kept, and a convenient arrangement of machinery and other equipment. The building has a coal bin, a general-storage room, a refrigerator room, a boiler room, and a churn room. There is a milk vat *a*, a separator *b*, a skim-milk can *c*, a cream vat *d*, a Babcock tester *e*, a combined churn and butter worker *f*, a boiler *g*, an engine *h*, an overhead shaft *i* that transmits power from the engine to the churn, a printing table *j*, and a wash sink *k*. Such a building can be constructed of any material that is desired. The floor should be made of cement and slope to a gutter extending along one side; this gutter should be connected to a tile drain or a sewer. It will be necessary to have a water system of some kind in such a building.

CREAM-SEPARATING EQUIPMENT

CENTRIFUGAL SEPARATORS

9. Centrifugal separators are machines that mechanically separate cream from milk. They are not an absolute necessity in the making of butter on farms, but owing to the fact that centrifugal separation of cream has many advantages over separation by gravity it will usually be found a matter of economy and convenience to purchase a centrifugal separator, even though the first cost is somewhat large. The relative advantages and disadvantages of centrifugal and gravity separation will be discussed later.

10. Explanation of Centrifugal Separation.—Centrifugal separation is based on the principle that when an object is revolved on its center the component parts tend to fly outwards, or away from the center; the greater the speed of

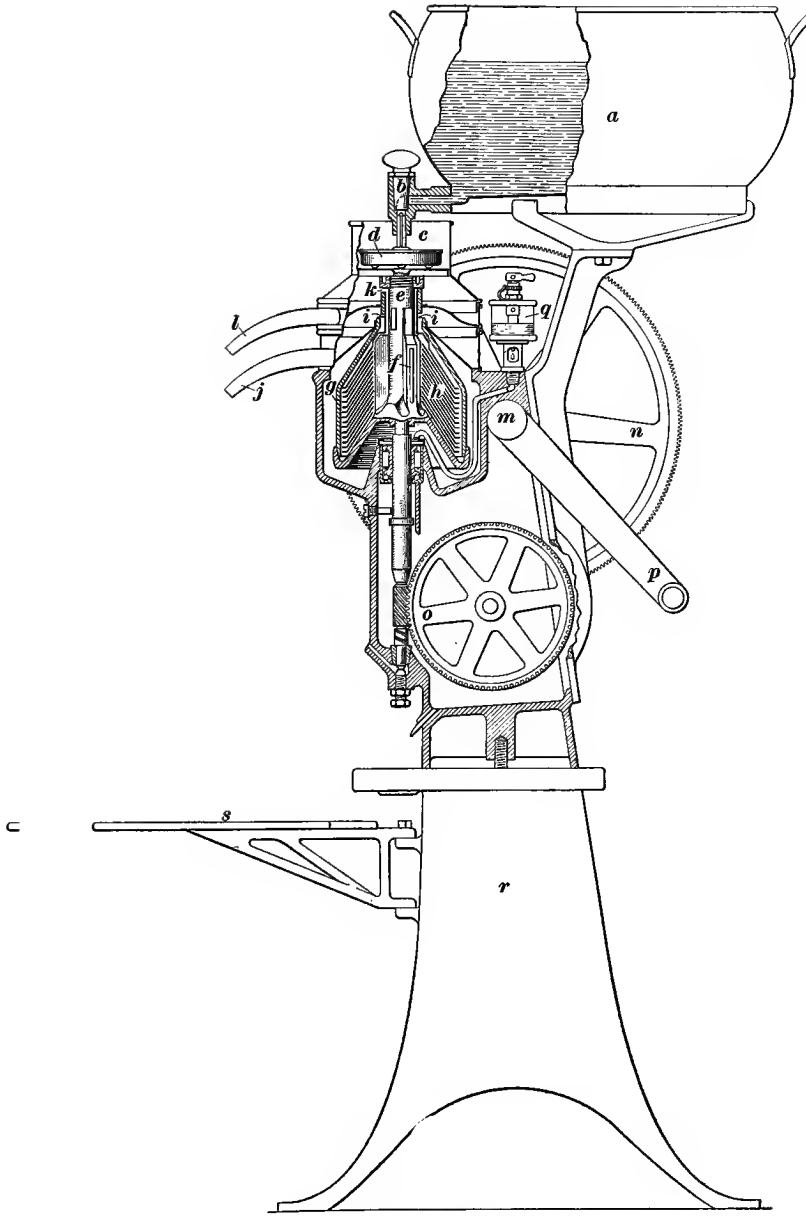


FIG. 2

revolution and the heavier the component parts the greater will be this tendency, which is known as centrifugal force. As cream is composed of the lightest constituents of milk, it is apparent that if whole milk is revolved at a sufficient speed in a closed compartment, the heavier particles will fly to the outer edge, leaving the cream at the center. Although the various types of centrifugal separators on the market differ considerably in mechanical construction, the working principle is the same in all.

11. Centrifugal-Separator Mechanism.—A general idea of the mechanism of a centrifugal cream separator may be had from Fig. 2, which shows a representative type of machine with a section cut away to illustrate the interior construction. The milk is delivered from the tank *a* through the cock *b* to the chamber *c*, where is it kept at a constant level by the float valve *d*. From *c* the milk flows downwards through the tube *e* and is distributed through longitudinal openings, one of which is shown at *f*, to the interior of the bowl, the outer wall of which is shown at *g*. The bowl in the separator illustrated is a plain, tinned-steel cylinder that is covered with a conical top and which, in the model shown, is $5\frac{3}{4}$ inches high and $4\frac{1}{4}$ inches in diameter. The bowl contains a number of metallic cones *h*, which are placed about $\frac{1}{16}$ inch apart. As the milk is distributed to the interior of the bowl it is divided into thin sheets by these cones. The heavier part, or the skim milk, is thrown to the outer edge of the bowl and the cream is forced to the center. Due to the pressure of the incoming milk, the skim milk is forced upwards along the outer edge of the bowl until it reaches the outlets, one of which is shown at *i*, and is discharged through the spout *j*. Likewise, the cream is driven upwards along the tube *e* until it reaches the outlet *k*, from which it is discharged through the spout *l*. The cream outlet is equipped with a screw, which is not shown in the illustration, for regulating the thickness of the cream. The power for operating the machine is applied through the spindle at *m*, the gearings *n* and *o*, and the handle *p*. Oil is applied to the bearings

through the oil cup *q*. The apparatus is supported by a metal base *r*, which is provided with a shelf *s* for supporting the vessels that catch the skim milk and cream as they are discharged.

12. Types of Centrifugal Separators.—Centrifugal separators are of two general types, *hollow bowl* and *complex bowl*. Hollow-bowl separators are classed as plain and tubular. Complex-bowl separators are divided into two classes, the vertical-sheet type and the horizontal-sheet type, the classification being based on the general plane in which the milk is divided into thin sheets in the bowl.

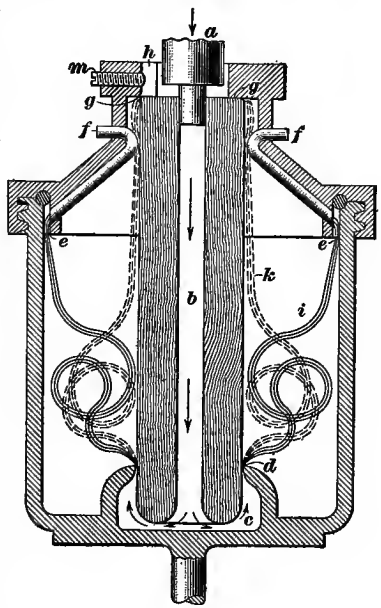


FIG. 3

13. Hollow-bowl separators of the plain type were the first to be placed on the market. They are cheap, easily cleaned, and, when well made, are durable. They are not, however, extensively used at the present time, because their capacity is limited as compared to that of other types of the same size. In addition, plain hollow-bowl separators do not skim as closely as other types of separators. Fig. 3 shows a sectional view of a common form of bowl that is used on this type of separator. The milk enters at *a*, flows through the tube *b* to the bottom of the compartment *c*, from which it is forced upwards by the pressure of the incoming milk through the passage *d* into the separating chamber of the bowl, as indicated by the arrows. The skim milk is thrown to the outer edge of the bowl and rises to the point *e*, from which it is discharged through the tubes *f*. The cream rises along the outside of the tube *b* to the point *g*, where it

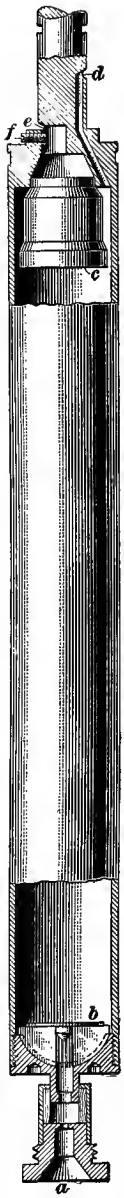


FIG. 4

passes through small openings and is discharged at *h*. At *m* is shown a cream screw for regulating the thickness of the cream. In this type of bowl there is an objectionable intermingling of the skim milk and cream, as shown by the solid lines *i* indicating the skim-milk current and the broken lines *k* indicating the cream current. Another objectionable feature is that considerable time is required for the milk to acquire the speed of the bowl, which is the speed at which separation takes place, because only the milk next to the outer and inner walls of the bowl is at first affected by the friction of the revolving parts.

The hollow-bowl separator of the tubular type is simple in construction and does much more efficient work than the plain hollow-bowl separator, due, in part, to the fact that the former has a much longer bowl than the latter and the milk, in passing through it, is subjected to centrifugal force for a greater length of time. A sectional view of a tubular bowl is shown in Fig. 4. The milk enters at the bottom at *a*, jets up into the bowl against the wing *b*, which is constructed so that it serves to communicate to the milk the revolving motion of the bowl. The milk flows upwards around the wing into the separating compartment, where it is soon separated. The skim milk is forced outwards against the wall of the bowl and, rising, passes between the dividing wall *c* and the wall of the bowl and is discharged at *d*. The cream rises along the inner side of the skim milk, near the center of the bowl, and passes inside of the dividing wall, which directs it to the cream outlet *e*. The screw for regulating the thickness of the cream is shown at *f*. The tubular bowl is easy to clean and does much more efficient skimming than the plain hollow bowl. However, on account of the small diameter of the bowl, tubular separators must be operated at a

much higher speed than other types. This requirement is provided for by suspending the bowl from a single ball bearing. The tubular-bowl separator is extensively used by butter makers and has, in most cases, given excellent satisfaction.

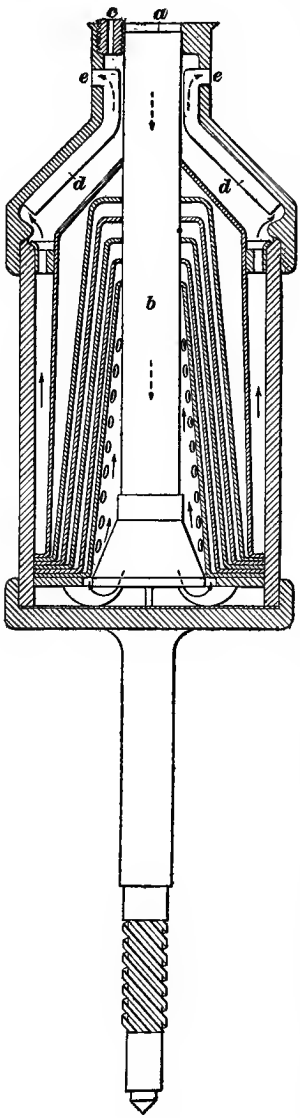


FIG. 5

14. A **complex-bowl separator** of the vertical-sheet type is illustrated in Fig. 5. The milk enters at *a*, flows downwards through the central feed-tube *b* to the bottom, and is discharged into the first compartment, or that formed by the smallest cone, as indicated by the arrows. Separation begins in this compartment. The largest particles of butter fat—those most easily separated—find their way up along the feed-tube to the cream outlet *c*. The skim milk and the smaller particles of cream pass through the perforations in the first cone into the second compartment, or that formed by the next largest cone, where another separation takes place, the cream being forced up along the inner wall of the compartment and the milk being forced through the perforations of the second cone into the third compartment. The cones are octagonal in shape, with perforations at the corners, and as the bowl revolves the milk is forced through the perforations at the points farthest from the center of the bowl. The cream passes up

the flat, outer surface of the cones and does not intermingle with the skim milk or the whole milk. This process is repeated in each compartment, the milk being partly separated in each one. From the last compartment the skim milk flows into the passageway *d* and is discharged at *e*. This type of separator has, in most cases, proved satisfactory. Its chief disadvantage lies in the somewhat tedious process of washing the perforated cones.

In Fig. 6 is shown a sectional view of one of the best forms of the horizontal-sheet type of bowl. The whole milk enters the central feed-tube at *a*, flows downwards, and is distributed to the cones through longitudinal openings, one of which is shown at *b*. There are in this bowl twenty-seven non-perforated disks $\frac{1}{16}$ inch apart, but only three disks are shown in the illustration for convenience in explanation. When the milk enters the disk chamber it is temporarily at the point *c* between each disk. Separation immediately takes place, the cream traveling $\frac{1}{32}$ inch to the lower disk and the skim milk $\frac{1}{32}$ inch to the upper disk; both are driven along the surfaces of these disks, the cream to the cream zone along the feed-tube and the skim milk to the outer wall of the bowl, and both are then forced to rise, the skim milk to the outlets *d* and the cream to the outlet *e*, as indicated by the arrows. Separators having this type of bowl are operated at a comparatively low speed and have a high skimming efficiency. The only objectionable feature about them is the fact that considerable time is required to wash the disks.

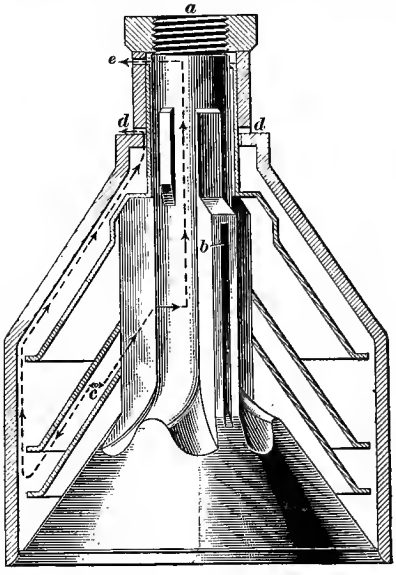


FIG. 6

DEVICES FOR GRAVITY SEPARATION

15. Cream is much lighter in weight than skim milk; consequently, when whole milk is allowed to stand in vessels without being stirred, the cream forms in a layer at the surface, due to the force of gravity pulling the heavier milk particles to the bottom. Normal whole milk always separates into skim milk and cream if permitted to stand for a sufficient length of time. This natural separation of milk is known as **gravity separation.** There are three processes of gravity separation; namely, *shallow-pan separation, deep-setting separation,* and *water-dilution separation.* The process of **shallow-pan separation** consists of pouring freshly drawn milk into shallow vessels so that the milk will stand at a depth of from about 2 to 4 inches and then setting these vessels in a temperature of not higher than 60° F. for from about 24 to 48 hours, or until the cream has collected at the surface; the cream is then removed by means of a skimmer. In the process of **deep-setting separation** the milk, immediately after being drawn, is poured into cans of about 24 inches in depth and not more than 8 inches in diameter, and these cans are then submerged to within a few inches of their tops in cold water for several hours, or until the cream has collected at the surface; the cream is either removed with a skimmer or the skim milk is drawn off from under it through a faucet in the bottom of the can. In the process of **water-dilution separation** the freshly drawn milk is poured into cans of from about 24 to 36 inches in depth and is then diluted with about an equal quantity of cold water at a temperature of not more than 50° F.; when the cream has collected at the surface it is either skimmed off or the skim milk is drawn off from under it.. This method varies somewhat in different sections of the country, but the description of the process just given applies to the popular practice.

These methods of separation are defined here to give an idea of the equipment that is required and to render an explanation of it intelligible. The various methods of cream separation will be discussed in detail later.

16. Devices for Shallow-Pan Separation.—Little equipment is needed for the shallow-pan process of separation. All that is required is a sufficient number of suitable vessels to contain the whole milk, and a skimmer for removing the cream. A convenient kind of vessel for containing the milk is a round, pressed-tin pan of about 3 inches in depth and from 10 to 14 inches in diameter. Earthenware crocks that are about 4 or 5 inches deep and from 10 to 12 inches in diameter are often used as milk containers for the shallow-pan process, but they are somewhat heavy, are easily broken, and the glazing cracks if the crocks are properly scalded in being cleaned.

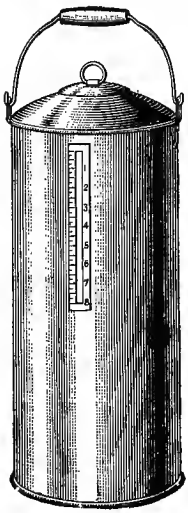


FIG. 7

For convenience, a skimmer with a slightly concave bowl and a short handle should be provided. The exact kind to use is not important, as there are on the market a variety of skimmers that will give satisfaction.

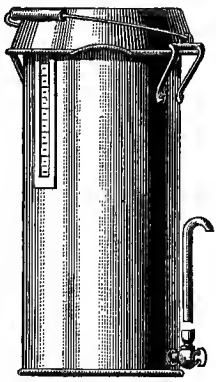


FIG. 8

17. Devices for Deep-Setting Separation.—For deep-setting separation, the equipment can be as simple or as elaborate as is desired. A variety of devices for this process, some of which have little merit, are on the market. All the equipment that is actually needed is a sufficient number of suitable cans to contain the milk, a tank in which to set the cans, and some form of skimming device. A cheap form of can for this process is illustrated in Fig. 7. This kind of can is made of heavy tin plate, smoothly soldered, and is provided with a tin cover, a bail, and a glass gauge for indicating the depth of cream in inches. Such cans should be about 8 inches in diameter and from 22 to 26 inches in depth. The cream can be removed with a skimmer. Cans with a faucet for drawing off the skim milk can be purchased if desired.

The Cooley deep-setting can, one of which is shown in Fig. 8, is provided with a faucet and siphon for drawing off the skim milk from under the cream. In the illustration the siphon tube is shown detached from the faucet, to indicate the way it can be removed for washing. This type of can is now used very little, although at one time it was popular.

When the deep-setting process of separation is employed, it is necessary either to make a tank for holding the cans or to purchase one of the various patented devices that are designed for this purpose. A good type of home-made tank is shown in Fig. 9. Such a tank should be made of good, 2-inch oak, ash, or pine boards. The edges should be smoothly planed to prevent leakage, and the ends should be fastened together by means of rods. An inlet pipe should be provided if the tank is to be connected with a water system, and an overflow opening should be made about $1\frac{1}{2}$ inches below the level of the can tops. Several coats of paint on both the inside and the outside will aid in making the tank water-tight. Tanks similar to the one illustrated can be purchased from dealers in dairy supplies, or the ordinary galvanized steel tanks commonly used on farms for the watering of stock will give satisfaction.

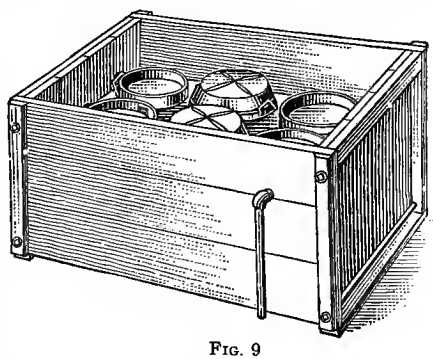


FIG. 9

The popularity of the deep-setting process of separation for farm butter making has led to the introduction of elaborate devices for cooling the cans, skimming off the cream, and lifting the cans from the water. A device that embodies some of these features and that is commonly known as a creamer, or, erroneously, as a creamery, is shown in Fig. 10. It consists of a cabinet of standard refrigerator construction for holding from two to twelve cans, depending on the size, and has a compartment lined with galvanized iron for con-

taining ice or cold water. The milk, while warm, is placed in the cans, which are surrounded by water at a temperature of not more than 50° F., or by ice. When the cream has all raised, the skim milk is drawn off to the cream line, which can then be seen through the glass, at the bottom of each can, and the cream is drawn off into a separate vessel. Some kinds of creamers are provided with zinc shelves so that they can be used as refrigerators for food.

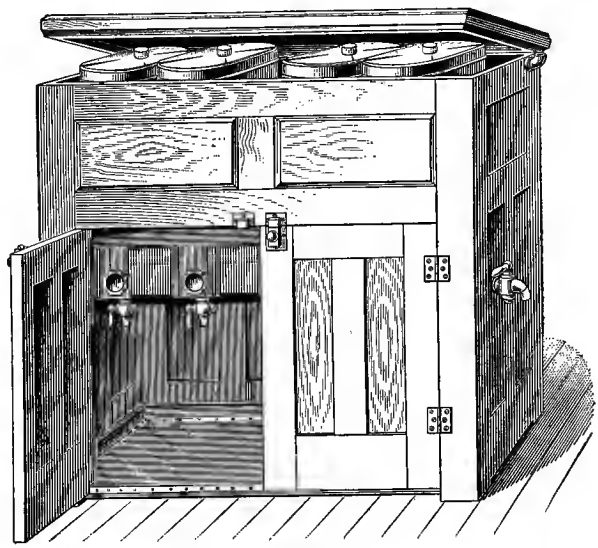
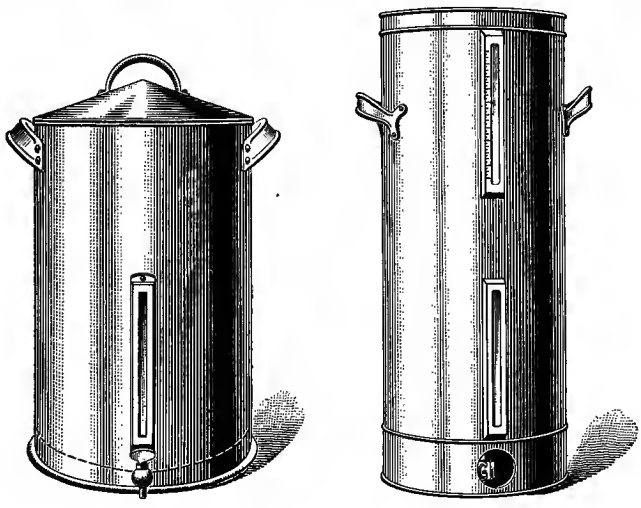


FIG. 10

18. Devices for Water-Dilution Separation.—There are on the market a number of the so-called water-dilution separators. These are merely deep cans that are fitted at the bottom with some device for drawing off the skim milk and usually with one or more glass gauges through which the cream can be seen. Two representative types of water-dilution separators are shown in Fig. 11. In the type of separator shown in (*a*), the bottom is concave, as indicated by the dotted line. A faucet is provided in the side of the can at the lowest point in the bottom for drawing off the skim milk.

A glass gauge is inserted in one side of the can near the bottom so that it is possible to ascertain when all the skim milk has been withdrawn. The can is fitted with a cover and with handles. The type of can shown in (*b*) has a false bottom in which a faucet is placed, and an opening is cut in the side of the can below the false bottom so that the faucet can be reached with the fingers. This type of can has two



(*a*) (*b*)

FIG. 11

glass gauges, the one at the top being calibrated so that the depth of the cream can be read, and the one at the bottom being similar to that shown in (*a*). No cover is provided for this type of can, but it is advisable to keep the top covered with a cloth to exclude foreign matter while the cream is rising.

CHURNS

19. Churns are devices used for agitating cream so that the butter-fat globules are brought together into masses of butter of such size as to enable the butter maker to separate them from the buttermilk. Modern churns are of three types: the *dash*, the *revolving*, and the *swinging*. In the dash type

of churn, the cream is placed in a square or cylindrical container and is agitated by means of a dash, or plunger, operated in a vertical direction within the compartment. In the revolving type, the cream container is revolved on its horizontal axis and the cream is agitated by being constantly dashed against the walls. In the swinging type, the cream container is swung back and forth in a more or less horizontal

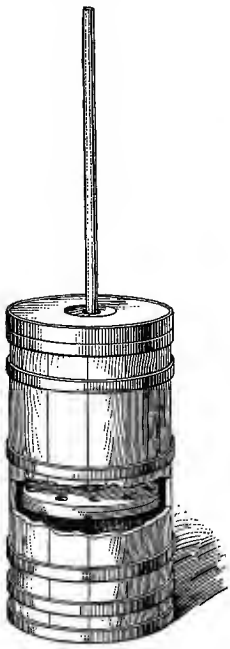


FIG. 12

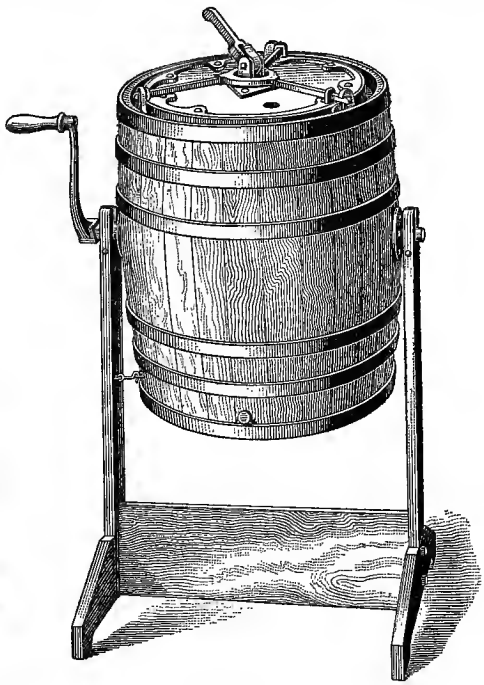


FIG. 13

direction and agitation is accomplished by the cream alternately dashing from end to end. The dash type of churn can be operated to the best advantage by hand power. The revolving and swinging types are equally well adapted for either hand or mechanical power.

20. Dash Churns.—In Fig. 12 is illustrated a common form of dash churn. This churn is simple in construction, consisting of a barrel-like cream container, which is made

of wooden staves bound together by hoops, and a perforated dash. Churns of this type can be purchased in a variety of sizes. The disadvantages of the dash churn are that it has a low churning efficiency, wastes considerable cream by splashing it out through the dash opening in the cover, requires considerable labor to operate, and produces butter of an inferior texture. The dash churn is not to be recommended under any condition.

21. Revolving Churns.—A convenient form of revolving churn is shown in Fig. 13. This is known as the barrel churn. It consists of a small wooden barrel that is suspended at its center on each side by means of gudgeons that fit into notches cut into the supporting standards, a lid that can be tightly clamped in place, and a crank-shaft and crank by which the barrel can be turned. A small glass is provided in one end of the barrel as an aid in ascertaining when the churning is finished. The barrel can be maintained in an upright position by means of a hook and staple, as shown in the illustration. A vent in one end permits air to escape when the plug is removed. A barrel churn should be of such size that it is never necessary to fill it over one-third full of cream. Barrel churns are easy to operate and to keep clean, and will last indefinitely if properly cared for.

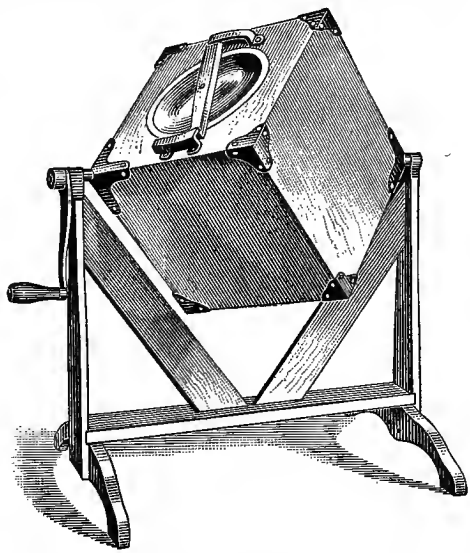


FIG. 14

Another form of revolving churn that is widely used is the rectangular churn, illustrated in Fig. 14. This churn is

similar to the barrel churn in all points except the shape of the cream container, which is rectangular. The container is suspended in the frame by gudgeons in two of the opposite corners. It is made of wood and the corners are reinforced with metal. The rectangular churn produces a good quality of butter and its churning efficiency is about the same as that of the barrel churn, but because of the corners it is somewhat more difficult to wash. Another objection is that such churns usually become leaky after a little use.

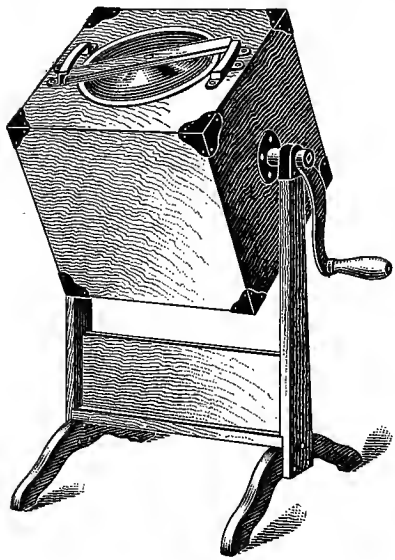


FIG. 15

In Fig. 15 is shown a square-box churn, which is exactly like the rectangular churn except in the manner in which the cream container is suspended in the frame. In the square-box churn, the gudgeons are attached to the sides of the box instead of to the corners as in the case of the rectangular churn. Some butter makers prefer the square-box churn, although it has no real advantage over the rectangular churn, and has all of the disadvantages of the latter.

In Fig. 16 is shown a form of combined hand- and mechanical-power revolving churn. This is simply a large-sized barrel churn that is fitted with a belt pulley. The pulley can be removed if desired and a crank used for turning the barrel.

A form of combined churn and butter worker is illustrated in Fig. 17. This churn has corrugated wooden rolls that operate in pairs in the interior for working the butter after it is churned. The two speeds required for churning and working the butter with this churn are obtained by means of gears attached to the pulley shaft; the gears may be shifted

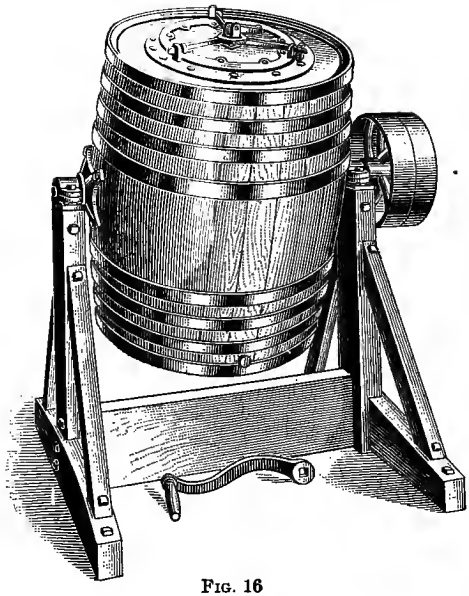


FIG. 16

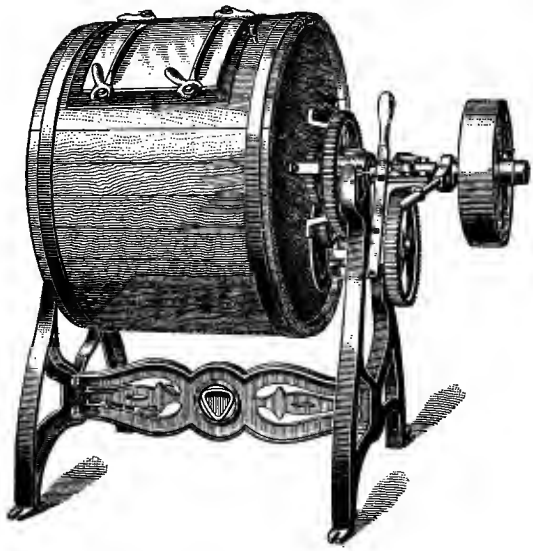


FIG. 17

at will by the operator. An important advantage of this churn is that the butter is not exposed to outside air at any stage of the churning process, but is protected from heat, dust, flies, or foul odors, and its natural aroma is preserved.

22. Swinging Churns.—In Fig. 18 is illustrated a popular form of swinging churn. This churn has an oblong wooden cream container suspended by means of iron rods from a framework. Cream is poured into an opening in the top of the container until the latter is about one-third full, or at most not more than one-half full, the cover is clamped in place, and churning is accomplished by swinging the churn back and forth. The swinging churn will complete the churning operation in about the same time that is required for any of the revolving churns, and produces a good quality of butter; its churning efficiency is about equal to that of the revolving churns. The swinging churn is one of the easiest forms on the market to operate, but it is not so easy to wash or to remove the butter from as barrel churns. Various forms of churns that utilize the swinging method of agitation are on the market.

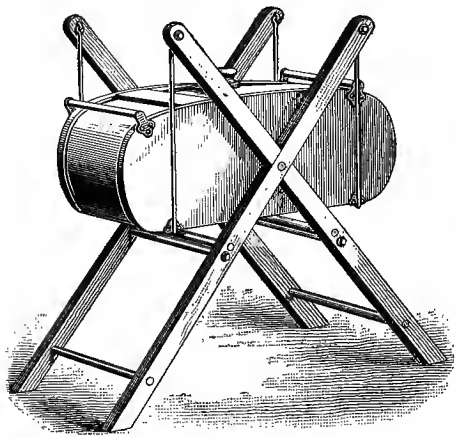


FIG. 18

MISCELLANEOUS EQUIPMENT

23. Power Outfits.—The advisability of purchasing a power outfit for butter making will depend on the quantity of butter that is produced on the farm. It is often possible to use a power outfit for a number of purposes besides that of making butter, and in this case such an outfit might be an

economical investment even if the quantity of butter produced is small. One of the cheapest and simplest forms of power that can be used for the various operations of butter making is animal power. A machine for the utilization of animal power is shown in Fig. 19. Dogs, goats, or sheep can be used for the operation of such a machine with little preliminary training. Animal power is satisfactory for such

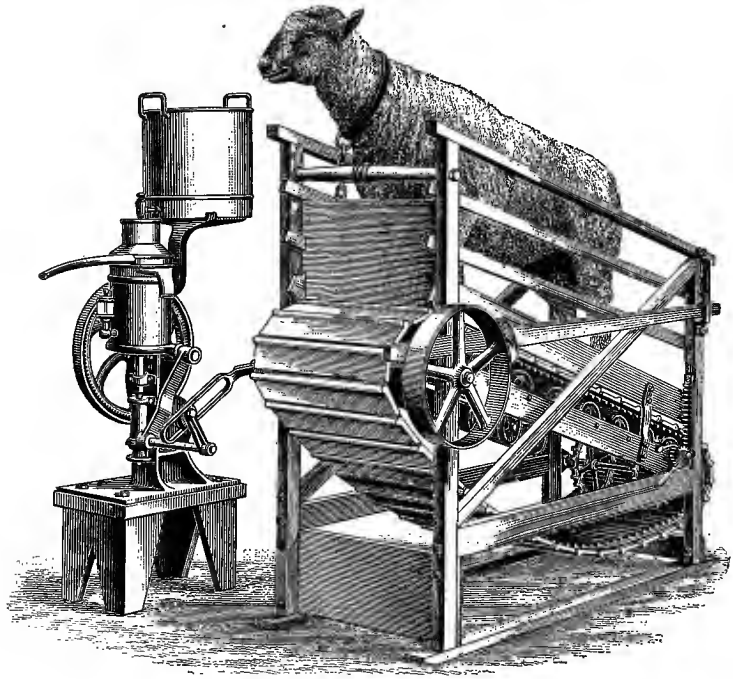


FIG. 19

light work as the separating of milk, churning, etc., but, of course, its range of work is limited.

24. The gasoline engine is one of the most common and desirable forms of power plants for use in farm butter making. It generates power cheaply and has a wide range of usefulness. When gasoline-engine power is used for the operation of centrifugal cream separators it is advisable to make use of

a device for governing the speed of the engine; such devices can be purchased from separator and engine manufacturers. An engine rated at from 1½ to 2 horsepower is a good size to purchase for the churning or separating of cream. Smaller sizes may be large enough to do the work, but they are more subject to speed variation than the larger engines and, besides, are more limited in their range of work.

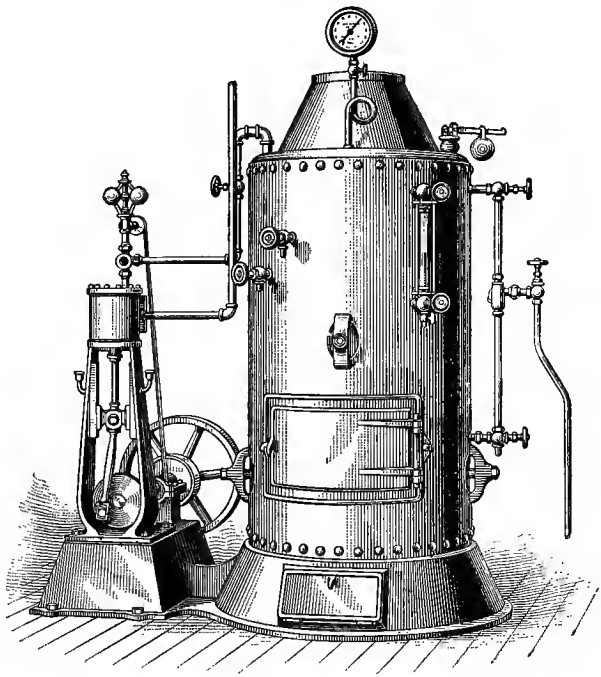


FIG. 20

25. Steam, where it can be economically used, is one of the most desirable forms of power for farm butter making. An advantage of steam over other forms of power is that it is very flexible—that is, it furnishes a greater range of speed and the speed is more easily controlled and maintained than when the power is supplied by other means. The chief advantage of steam is its value for heating water and sterilizing the dairy utensils. A desirable type of combined engine

and boiler for dairy use is shown in Fig. 20. Of course, if steam is wanted merely for sterilizing purposes or for running turbine separators or Babcock testers, the engine is unnecessary.

26. Pasteurizing Outfits.—The successful pasteurization of cream is a process that requires considerable time and an expensive outfit, and it is rarely practiced in farm butter making. For this reason the pasteurization of cream is not discussed in this Section.

27. Babcock Test Outfits.—The outfit required for the testing of whole milk by the Babcock test has already been explained and illustrated in *Milk*, Part 2. If the Babcock test is to be employed in testing cream, skim milk, and buttermilk, it will be necessary to provide additional equipment consisting of test bottles for cream, skim milk, and buttermilk, and a pair of scales for weighing the cream samples. In Fig. 21 (*a*) is illustrated one form of bottle used for testing cream. This bottle has a neck with a large opening and is calibrated for registering 30 per cent. or less of butter fat. In (*b*) is illustrated the bottle used for testing skim milk or buttermilk, the same bottle being used for both. This bottle has a double neck, one neck providing the opening for filling the bottle and the other for registering the per cent. of butter fat in the sample. Each calibration on this bottle indicates $\frac{1}{20}$ of 1 per cent. of fat. Due to the fact that accurate samples of cream cannot be obtained by means of a pipette, it is necessary to weigh the samples. For the weighing of cream, scales such as the pair shown in Fig. 22 are convenient. These scales have two pans, a sliding weight, and an indicator for showing when they are balanced.

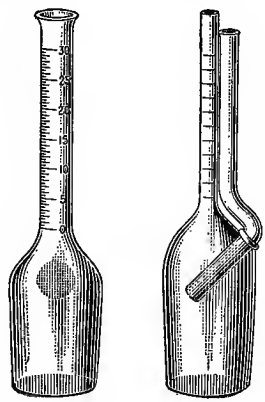


FIG. 21

28. Butter Workers.—For a quantity of butter such as is churned in a hand-power churn, the butter worker shown in

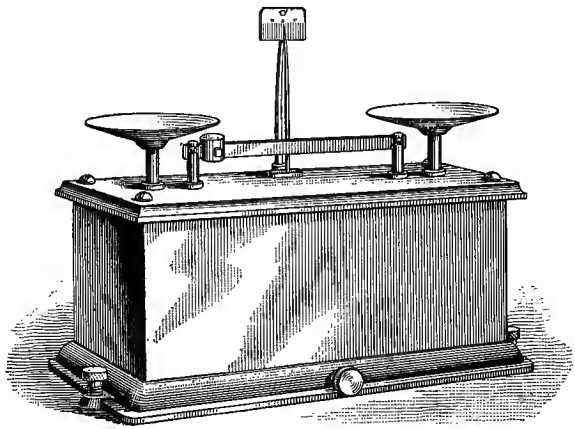


FIG. 22

Fig. 23 is one of the most desirable forms to use. It consists of a wedge-shaped wooden tray with a wooden lever pivoted at one end for working the butter. The buttermilk runs out through a hole in the narrow end. This form of worker, without legs, can be purchased if desired.

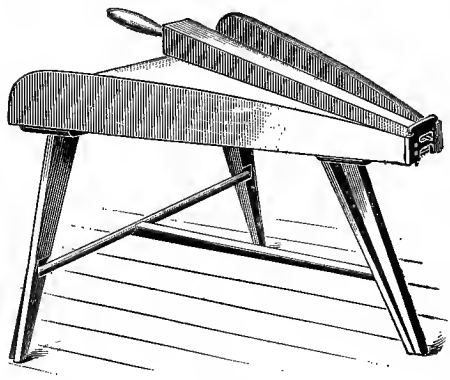


FIG. 23

In Fig. 24 is illustrated a form of butter worker that is sometimes used, especially when a considerable quantity of butter is churned and the churn is not provided with butter-working rolls. This machine consists of a shallow circular butter tray that revolves on rollers, two corrugated, conical workers, pulleys for operating the machine by mechanical power, and also a crank for turning it by hand.

The medium and larger sizes of mechanical-power churns have devices either that can be slid into the churn for working

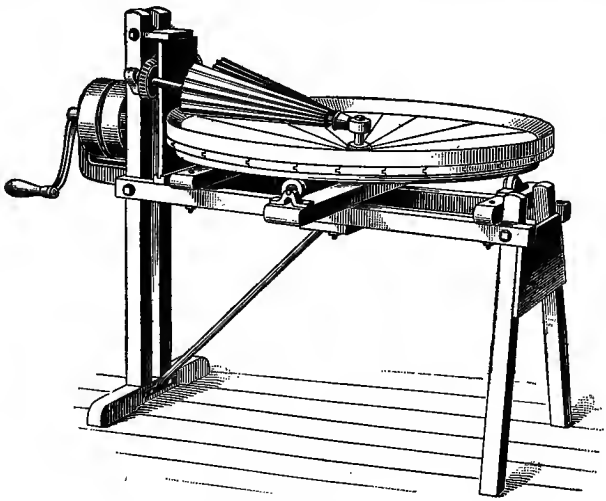


FIG. 24

the butter or that form a permanent part of the churn. Either of these devices do efficient work.

29. Butter Printers. — For average farm use, the simple butter printer that makes a brick-shaped print weighing approximately 1 pound is the most desirable. A printer of this type is shown in Fig. 25. The butter can be packed into the printer by a paddle or by simply placing the printer in the position shown in the illustration and forcing it down on the butter. Then by raising the printer and pushing on the plunger the butter is forced out. Care should be exercised

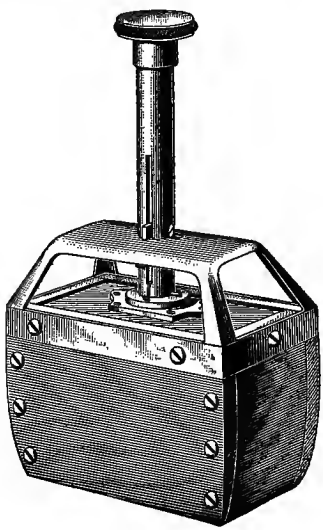


FIG. 25

to pack the butter firmly into the chamber or air spaces will be left in the print.

When larger quantities of butter are produced than can be conveniently handled by the printer just described, the form shown in Fig. 26 is sometimes used. The butter is packed into the compartment *a* by means of the packers *b*, care being taken to have the top of the butter level with the edges of the box; the wire cutting frame *c* is then let down over the

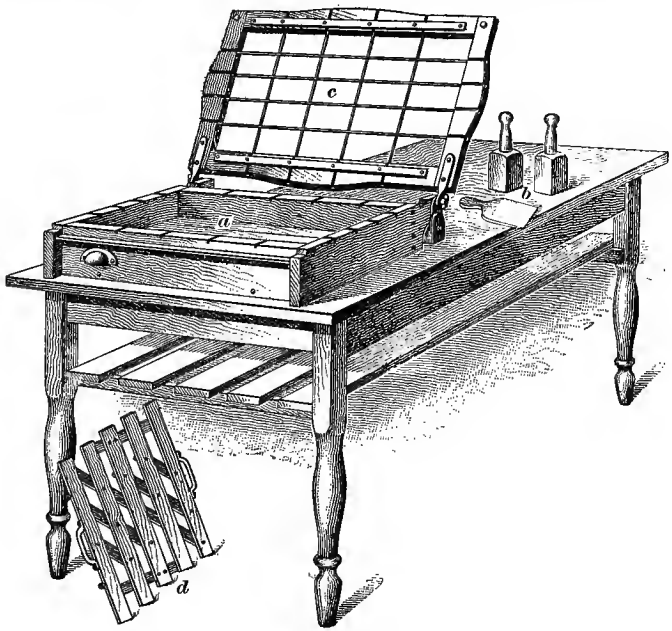


FIG. 26

butter and the printer is turned over so that the butter rests on the cutting wires. Next the flexible tray *d* is placed under the wires and the movable bottom of the chamber *a* is pushed down so that the butter is forced through the wires and thus cut into prints weighing about 1 pound each. The machine illustrated prints 25 pounds of butter at each operation, but smaller sizes of machines that use the same molding principle can be purchased if desired. The butter maker should, of

course, choose a printer that is certain to give accurate weight as well as one that is convenient.

30. Dairy Thermometers.—The dairy thermometer is one of the most essential parts of the butter-maker's equipment. Even if churning is done but twice a week and but a few pounds of butter are produced at each churning, a thermometer should be provided. Haphazard guessing at temperatures in the process of making butter is not conducive to the production of a good grade of butter.

The commonest form of dairy thermometer is the floating type shown in Fig. 27. This has at one end a bulb that contains mercury and that holds the thermometer upright in a liquid. There is a glass ring at the other end by which the thermometer can be lifted from its upright position. The dairy thermometer is calibrated like the common form of Fahrenheit thermometers.

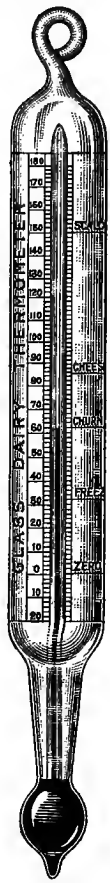


FIG. 27

31. Scrubbing Brushes.—A variety of scrubbing brushes adapted to the different machines and devices about the butter-making quarters is essential for keeping the equipment in a sanitary condition. In Fig. 28 are shown several brushes that will meet practically all requirements of an average-sized farm dairy. In (*a*) is shown a general-purpose brush for the scrubbing of butter trays and churns; in (*b*), a Babcock test-bottle brush; in (*c*), a churn brush; in (*d*), a milk-bottle or sample-bottle brush; and in (*e*), a rubber mop for drying tables and floors.

32. Manns's Acid-Testing Outfit.—Manns's acid test is a chemical test that is sometimes used by experienced butter makers for measuring the acidity of cream to be churned. By its use cream can be churned at about the same degree of acidity at each churning and thus a uniform grade of butter can be made. In Fig. 29 is shown the apparatus necessary

for making the test. It consists of a glass burette of 60 cubic centimeters, a pinch cock, a burette stand, a glass beaker and stirring rod, and a glass pipette of a capacity of 50 cubic centimeters for measuring the sample. The chemicals necessary for the test consist of a quantity of tenth-normal alkali solution made of caustic soda or caustic potash and water, and an alcoholic solution of phenolphthalein. The apparatus

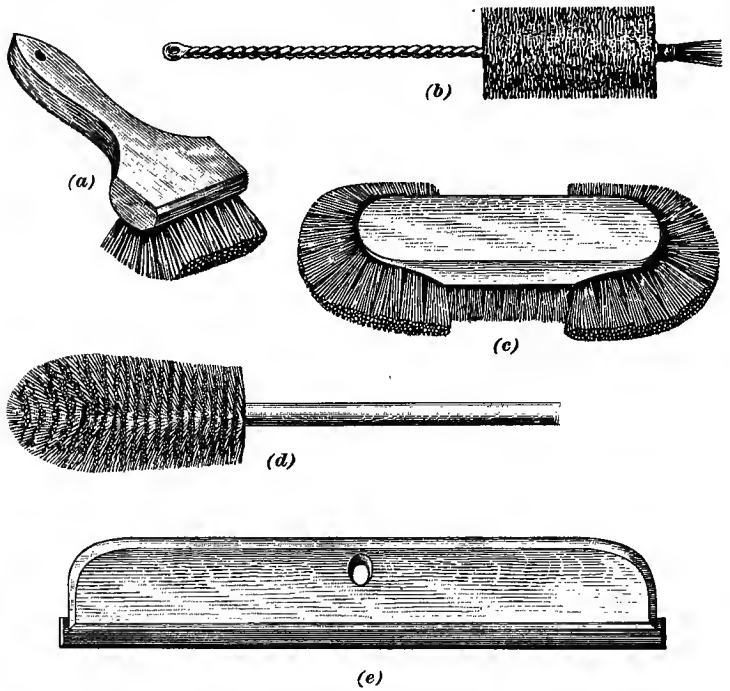


FIG. 28

and a sufficient quantity of chemicals for making 100 tests are sold in outfits by dealers in dairy supplies. The manner of making this test is explained later.

33. Farrington's Acid-Testing Outfit.—The Farrington alkaline-tablet test is another method commonly employed for measuring the acidity of cream. It is somewhat similar in principle to the Manns test but requires different apparatus

and chemicals. Fig. 30 shows the outfit that is usually sold for this test. It consists of a pipette of 17.6 cubic centimeters, two 100-cubic-centimeter glass cylinders fitted with stoppers, and a porcelain cup. Commercial alkaline tablets are used in the Farrington test in place of a solution. These tablets can be procured from dealers in dairy supplies. The manner of making this test is explained later.

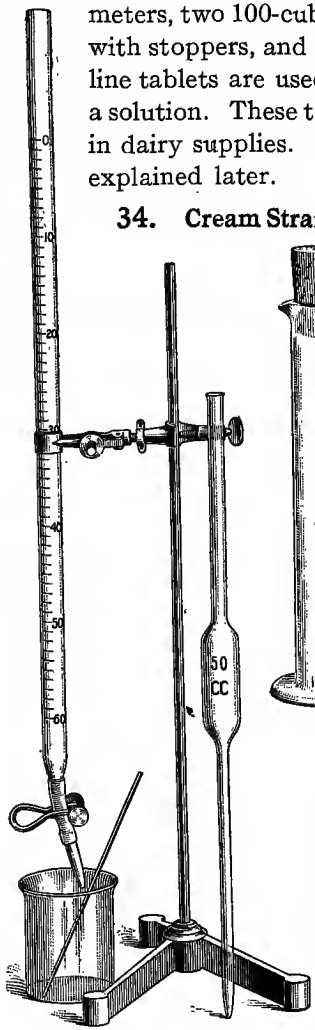


Fig. 29

34. Cream Strainers, Stirrers, and Samplers.—Most

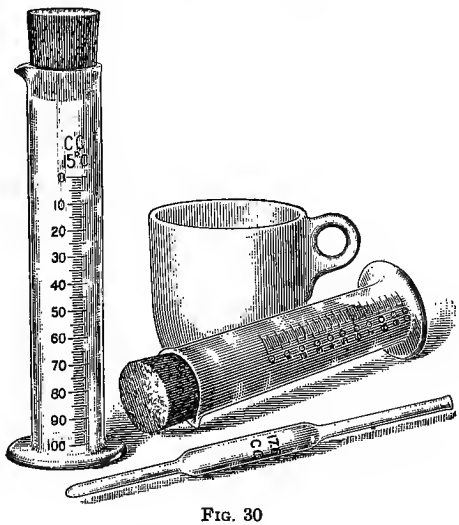


Fig. 30

of the cream strainers on the market do satisfactory work, consequently the selection of a strainer is not an important consideration. It is advisable, however, as a matter of convenience, to procure a strainer that can be suspended in the churn opening. Some of the manufacturers of churns provide a strainer with each churn that is sold, and where this is done it is not necessary to provide an additional one. A common form of strainer is shown in Fig. 31. It consists

simply of a conical tin vessel provided with a wire-screen bottom of suitable mesh. This type of strainer is convenient to use with small hand-power churns.

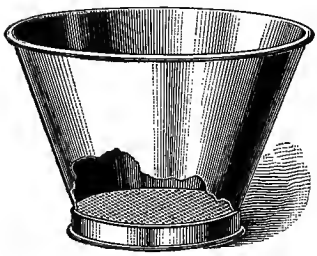


FIG. 31

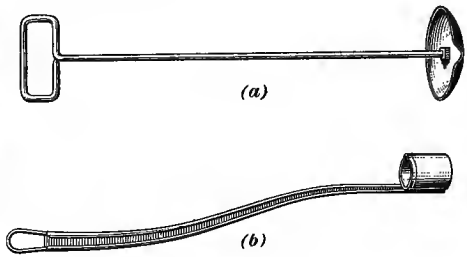


FIG. 32

In Fig. 32 (*a*) is shown a combined cream stirrer and sampler. This is a rod with a handle on one end and a shallow cup on the other. A rod of this kind is convenient

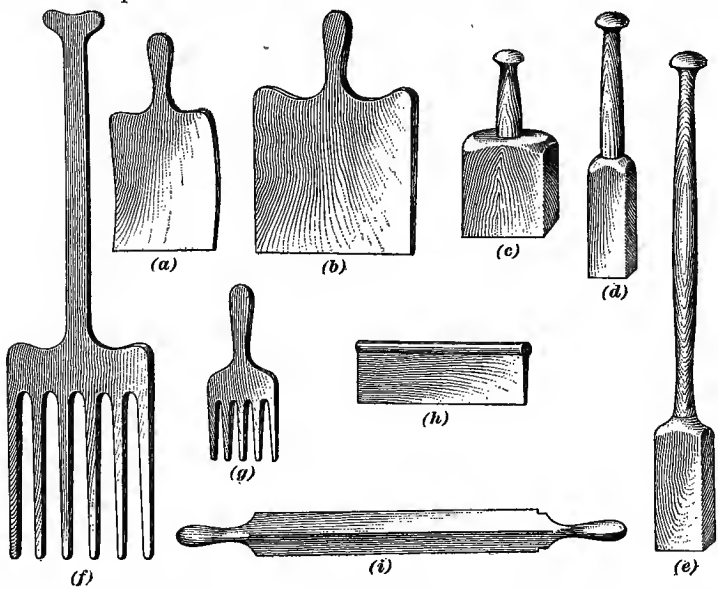


FIG. 33

to have in the dairy quarters and can be used for a variety of purposes. In Fig. 32 (*b*) is shown a cream sampler for taking out samples for the Babcock or acid tests.

35. Butter Ladles and Packers.—If a hand-power churn and a single-print butter printer are used in the making of butter on the farm, but one or two simple wooden ladles will be necessary. For large-sized mechanical-power churns and automatic printers, several of the heavier ladles and packers should be used. Fig. 33 shows a variety of ladles and packers for the handling of butter; in (*a*) and (*b*) are shown small ladles; in (*c*), (*d*), and (*e*), packers; in (*f*) and (*g*), forked ladles; and in (*h*) and (*i*), levelers.

BUTTER-MAKING OPERATIONS

SEPARATION OF CREAM

CENTRIFUGAL SEPARATION

36. Process of Centrifugal Separation.—The first step in the centrifugal separation of cream is to see that the milk is at the proper temperature. The best practice on the farm is to separate the cream immediately after the milk is drawn from the cows, thus taking advantage of its animal heat. In case the milk becomes cold before the cream is separated, it should be heated either by setting the milk cans on a stove and stirring the milk constantly or by setting the cans in hot water; the latter method is preferable, because of the reduced danger of scorching the milk. The temperature should be raised to about 80° or 90° F.

When the milk is at the proper temperature it is poured into the tank on the separator, the latter is started, and the milk is admitted to the bowl by means of a stop-cock. Care should be taken to have the separator running at its proper speed before the milk is admitted to the bowl, or inefficient separation of the first milk will result. In cold weather, it is advisable to flush the bowl with warm water before admitting the milk. It is the custom of separator manufacturers to stamp the most efficient separating speed of each model of

separator on the crank handle in terms of revolutions of the crank per minute; thus, if "40 R. P. M." is stamped on the crank, it means that the operator should turn the crank forty times per minute as timed by a watch. One of the patented speed indicators for machines may also be used for this purpose and is considerably more convenient for the purpose than a watch. The separator should be maintained at a uniform speed throughout the separation, as any considerable variation lessens the separating efficiency. If the milk supply in the tank becomes low and it is necessary to run the machine empty for a short time until more milk can be added, the separator should be flushed with about a quart of warm water to prevent it from becoming clogged.

After the separation is finished the machine should first be flushed with warm water and then the bowl and tubes taken apart and thoroughly washed in warm water and aklaline washing powder by means of the bristle brushes that are provided with the separator. Scalding water should never be used for the first washing of centrifugal separators, as certain constituents will become scalded on the metal parts and hence will be difficult to remove. Of course, after the parts have been thoroughly cleaned they should be sterilized in boiling water or live steam. Care should be taken in handling the devices on the inside of the bowl so as not to injure them in any way. After the parts are sterilized they should be stood up over a drain to dry before being put together again. Specific directions are given with each separator for its proper care.

37. Advantages and Disadvantages of Centrifugal Separation.—The advantages of centrifugal separation as compared to gravity separation are numerous. One of the greatest of these advantages lies in the fact that by the centrifugal method milk can be separated immediately after it is drawn from the cows, thus avoiding the probability of it becoming contaminated to a greater or less extent by standing exposed to the air for several hours, as in the case of gravity separation. Also, a centrifugal separator of the best kind will leave less

than $\frac{3}{100}$ of 1 per cent. of butter fat in the skim milk, as compared to a loss of from .2 per cent. to 1 per cent. by the best gravity method. By the use of the centrifugal separator, it is estimated that, under average conditions, there will be a gain in butter fat over that obtained by gravity separation amounting to from $5 to $8 per cow per year. At this rate a separator will soon pay for itself. In addition, it is usually easier to obtain the proper temperature of milk for centrifugal separation than for gravity separation. Another important advantage of centrifugal separation is that cream of a better quality and consistency for churning is obtained than by the gravity method, by which the cream is often lumpy and leathery, and more or less mixed with skim milk. Many impurities, such as hair, small insects, and undesirable bacteria are removed by the centrifugal method; in the gravity method, such foreign matter may be skimmed off with the cream, and perhaps transmitted to the butter. By the centrifugal method the skim milk is fresh and warm for feeding purposes and is left in an unadulterated condition.

The disadvantages of centrifugal separation are: the initial cost of the separator, the time and labor required for the operation of the machine, and the work entailed in washing the separator after each operation.

GRAVITY SEPARATION

38. Shallow-Pan Separation.—As has already been stated, in shallow-pan separation of cream the whole milk is allowed to stand in shallow vessels in a temperature of not higher than 60° F. until the cream has risen to the surface, after which the cream is skimmed off. A lower temperature than 60° F. is desirable if conditions will permit. The air in the quarters in which the milk is standing should be pure, free from dust and objectionable odors, and not subject to drafts, as a constant current of air over the milk is likely to cause the cream to be leathery. After the cream has formed it is removed by means of a skimmer. A good method of skimming off cream is to lift the pans carefully to a bench and

with a clean knife break the cream away from the sides of the pan, draw the cream gently to one side of the vessel, and dip it off with the skimmer.

The shallow-pan system has the advantage of a low cost for equipment and a simplicity of operation. Formerly, it was the most common method of separation used throughout the country on farms where but a few cows were kept. However, it has the objectionable disadvantage of giving a comparatively poor quality of cream, because of the length of time the cream must be exposed to souring and contaminating conditions before it is skimmed. Butter made from shallow-pan-separated cream will not keep fresh long. Also, even under the most favorable conditions, about ½ per cent. of butter fat will remain in the skim milk, thus making the method far from economical.

39. Deep-Setting Separation.—When the deep-setting process of cream separation is employed, it is advisable to pour the milk into cans immediately after it is drawn and partly submerge the cans in as cold water as can be obtained. The rapidity with which the cream will rise depends on the temperature of the water; if the water is at 50° F., all the cream that it is possible to obtain by this system will rise in 24 hours, and if the temperature can be held at 40° F., the same quantity of cream can rise in 12 hours. Thus it can be seen that, if time is an important consideration, intensely cold water or ice may be used to advantage. When the cream has completely risen the skim milk can be drawn off into one vessel and the cream into another, or, if the can is not fitted with a siphon or faucet, the cream can be removed with a skimmer. It is best to draw off the skim milk closely, as the smaller the quantity of skim milk in the cream the better the latter will keep and the better will be its quality.

The deep-setting system of separation, on account of the high quality of cream produced when it is practiced, is coming into general use where centrifugal separators are not used. The rapid cooling of the milk just after it is drawn from the cows and the low temperature at which it is maintained

during the rising of the cream tend to keep down undesirable bacterial growth. A thin cloth is usually tied over the top of the can to protect the contents from drafts and dust, thus insuring a good consistency of cream and a freedom from foreign matter that is often lacking in cream separated by the shallow-pan method. In addition, a much more thorough separation can be secured by the deep-setting system, as, when properly carried on, the fat can be removed so completely that not more than about $\frac{1}{5}$ of 1 per cent. of the total butter fat will be left in the skim milk.

40. Water-Dilution Separation.—When water-dilution separation is practiced, the usual custom is to pour the whole milk into the water-dilution separators immediately after it is drawn and dilute it by adding about an equal quantity of cold water. The separator is then set in a cool place until the cream has risen, when the skim milk is drawn off through a stop-cock in the bottom of the separator.

Notwithstanding its apparent advantages, water-dilution separation has never come into general favor throughout the country, for several reasons. One is that the cream obtained by this method is seldom of good quality, due to contamination from taints in the water used for dilution, and butter made from such cream has a washed-out, flattish flavor. Another reason is that the skim milk is robbed of its flavor for the calf or hog to which it is fed, and twice the quantity must be consumed by the animal to secure the same results obtained through feeding undiluted skim milk. Another somewhat objectionable feature connected with water-dilution separation is the comparatively large can or tank capacity required where considerable milk is produced. The greatest disadvantage of water-dilution separation is in the large quantity of butter fat that is lost when it is practiced. After extensive experiments, the Purdue University Agricultural Experiment Station, of Indiana, has found that in the state of Indiana the average loss of butter per cow per year, where water-dilution separation is practiced, is $40\frac{1}{2}$ pounds. This loss is almost twice as large as that resulting

from shallow-pan separation, which, in the same experiment, was found to be an average of $26\frac{1}{5}$ pounds of butter per cow per year. In comparison with the quantity of butter lost by deep-setting separation, which was found to be $10\frac{1}{10}$ pounds of butter per cow per year, the loss by water-dilution separation is almost four times as large. In comparison with the loss by centrifugal separation, which was found to be an average of only $1\frac{1}{5}$ pounds of butter per cow per year, that entailed through water-dilution separation is almost forty times as great. Because of the fact that water-dilution separation has so many disadvantages, it should not be practiced. It is explained in this Section only to permit of an understanding of its operation.

BABCOCK TEST FOR CREAM, SKIM MILK, AND BUTTERMILK

41. The Babcock method for the testing of cream, skim milk, and buttermilk is much the same as for the testing of whole milk, as explained in *Milk*, Part 2. There are, however, some important differences in the details of making the different tests that should be explained. The additional equipment that is needed for the testing of cream, skim milk, and buttermilk has already been described.

42. Testing of Cream.—For weighing the cream into the test bottles, a convenient method is to balance two cream bottles on the scales and then set the sliding weight at the 18-gram mark; this will make the weight of the scale pan on one side 18 grams more than that on the other side and the scales will be tilted toward the heavier side. Into the bottle at the lighter side, cream is then slowly dropped by means of a pipette until the two sides exactly balance again. The weight is then moved back to the zero mark and cream is dropped into the other bottle until the two sides balance. Thus, two 18-gram samples will be obtained. After the desired number of samples have been weighed, about 17.5 cubic centimeters of acid is added to each. The quantity of acid that is used must be varied slightly according to the

richness of the cream; rich cream requires less acid than cream not so rich, but the mixture of acid and cream must be given more time before being whirled in the tester. Care should be exercised in adding the acid to rotate the bottles or a scorching of the fat will result. After the acid has been added the mixture should be allowed to stand about 3 or 4 minutes before being placed in the centrifuge. The operation of the tester is the same as for whole milk.

In Fig. 34 is shown the proper method of reading the fat column in the testing of cream. Readings should be taken from *a* to *c*, as indicated by the brace, and not from *a* to *b*, or from *a* to *d*. Calipers should be used in reading the fat, as already explained for the testing of whole milk. In testing cream in an 18-gram bottle, the percentage of fat is obtained directly from the reading of the fat column. Thus, if the fat column, as measured by the calipers, extends from 0 to 28, there is a fat content of 28 per cent. In the illustration, the fat reading is 19½ per cent.

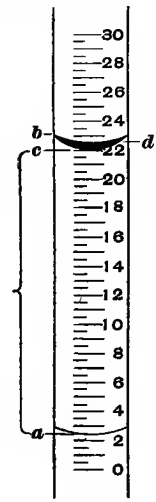


FIG. 34

43. Testing of Skim Milk.—In the testing of skim milk, a sample of 17.6 cubic centimeters is measured by means of a pipette and is then transferred to the test bottle. More acid should be used for skim milk than for whole milk—about 20 cubic centimeters should be used. Each bottle should be placed in the tester so that the filling tube will be toward the center, to avoid any of the fat being caught between this tube and the sides of the bottle when the latter assumes a vertical position at the end of the whirling. The tester should be operated at a slightly greater speed than for the testing of whole milk. In reading the percentage of fat in the bottle neck, it is usually necessary to use a pair of calipers, as explained for the testing of whole milk and cream. Often there is a layer of white or charred curd at the bottom of the fat; this should not be included in the fat reading. Each division on the scale of the skim-milk bottle represents $\frac{1}{20}$ of

1 per cent., and the marks are so far apart that the small column of fat can be estimated to even a smaller percentage.

44. Testing of Buttermilk.—The testing of buttermilk is accomplished with the same apparatus and by the same method as recommended for skim milk. Buttermilk tests are useful in showing the quantity of butter fat that is lost in the buttermilk.

RIPENING OF CREAM

45. Purposes in Ripening of Cream.—The development in cream of certain kinds of bacteria that break up the milk sugar into lactic acid and thus produce sourness, or acidity, is known as **ripening.** The ripening process is one of the most important steps in the making of butter, as the quality of the butter depends almost entirely on the control of conditions during the ripening. It is highly important that during the ripening process conditions be such as to be favorable to the multiplication of desirable bacteria and, at the same time, unfavorable to the development of bacteria that will have an injurious effect on the butter.

The chief purpose in the ripening of cream is to obtain a good flavor and aroma in the butter produced from it. Although bacteriologists disagree as to the exact source of flavor and aroma in butter, it is generally believed that these qualities are due to bacterial growth, and that bacteria that produce lactic acid are the most desirable ones to have present. At least flavor and aroma in butter go hand in hand with the proper ripening of cream, and it is impossible to produce a good quality of butter without ripening the cream.

Another purpose in ripening cream is to increase its churnability. The increased ease in churning is probably due to the action of the acid on the albuminous and caseous matter in the milk, making it less viscous and the movement of the fat through it, therefore, easier. Ripened cream can be churned at a lower temperature and in a thinner state than unripened cream. Also, if cream is ripened and churned at the proper temperature, it is possible to remove all but about $\frac{1}{10}$ of 1 per

cent. of butter fat, whereas if sweet cream is churned under exactly the same conditions, considerable more butter fat will be lost.

An important advantage in ripening of cream is that butter produced from such cream will keep fresh much longer than that produced from unripened cream. The cause for this lies in the fact that in the proper ripening of cream many or all of the bacteria responsible for deterioration of butter are suppressed. The germs that produce lactic acid have little deteriorating effect on butter; hence, cream ripened so that these germs predominate will produce not only a good quality of butter but a product that will keep well.

46. Explanation of Cream Ripening.—Cream ripening is of two kinds: *natural* and *artificial*. **Natural ripening** is the process by which cream becomes sour through the agency of the bacteria that it normally contains. **Artificial ripening** is the process by which it becomes sour through the agency of bacteria that have been introduced into it by man. Cream is ripened by the natural method by merely allowing it to stand in a temperature of from about 65° to 75° F. until it has reached the desired stage of acidity. Cream is ripened by the artificial process when lactic-acid bacteria are added to the cream and the cream is allowed to stand in a temperature of about 65° F. until it is sufficiently acid to churn. The medium that contains the lactic-acid bacteria is known as a **starter,** and is usually skim milk or buttermilk in which there is a preponderance of lactic-acid bacteria. A more detailed description of each process is given in the following pages.

47. Natural Ripening.—When cream is to be ripened by the natural method, extreme care should be exercised in handling the milk from the time it is drawn from the cows until it is separated, and in handling the cream from the time of separation until it is sufficiently ripe for churning. After skimming or separating the cream, it should be placed in a can or vat provided with some kind of cover that will exclude foreign matter and bad odors, preferably a tin cover, and the

vessel containing the cream set in some place where the latter is not likely to be contaminated. The best ripening temperature is from about 65° to 70° F. In winter, this temperature can be obtained by having a stove placed in the dairy quarters.

If churning is done but two or three times each week, the cream will, of course, be gathered in small quantities. The cream should be kept sweet, if possible, and at a temperature below 50° F. until enough has been gathered to make a churning. This should not be longer than 2 or 3 days at the most. If cream is kept longer than 2 days in hot weather, the butter is likely to have a stale flavor. While a churning is being collected, fresh cream should always be thoroughly cooled before it is added to a quantity previously collected. When it is desired to ripen the cream that has been gathered for one churning, it should be placed in a temperature of from 65° to 70° F. and held at that temperature for from 12 to 18 hours, or until it has reached the desired acidity. The cream should be stirred occasionally while it is souring. The methods of determining when cream is sour enough for churning are described later. After the cream has reached the desired stage of acidity it should be cooled to about 55° F. and maintained at that temperature until it is churned.

For farm butter making, where the milk is in the hands of the butter maker from the time it is drawn from the cows until it is churned into butter, the natural process of cream ripening is likely to be more satisfactory than the artificial process. In fact, to keep a good starter under farm conditions where churning is done but two or three times a week, is a difficult proposition. If the natural process of ripening is conducted properly, a good quality of butter can be produced. However, butter produced by this process will not be as uniform in flavor and keeping quality from week to week as will butter made from cream that was ripened by a starter.

48. Artificial Ripening.—Although the artificial ripening of cream cannot be unreservedly recommended for butter

making under average farm conditions, there may be times when such a practice is necessary. For example, it may be necessary, during cool weather, to use a starter in order to hasten the ripening process, or to control the ripening of cream when the milk from which it was taken has been subjected to contaminating influences. In case a starter is used, the butter maker should exercise extreme care in its preparation, as a poor starter is worse than none at all.

Starter can be obtained in several ways. On the farm the most common method is to use buttermilk from the last churning, provided the butter produced from that churning was of good quality. Such a starter works fairly well so long as the buttermilk can be kept free from undesirable ferments; there is a likelihood, however, of bacteria that produce bad flavors getting into the cream and being carried from one churning to another. If buttermilk starter is used, great care must be exercised to keep the flavor right and to provide fresh starter as soon as the buttermilk shows any sign of losing its flavor or aroma.

One method that has been recommended for obtaining a home-made starter is to milk a small quantity of milk—about 1 gallon is sufficient—in the most sanitary way possible; this can be done by brushing the cow carefully, wiping off her udder with a damp cloth, and milking into a pail that has been sterilized. This should give a quantity of clean milk that contains a relatively small number of germs. The pail containing the milk should be set in a warm place at about 70° to 75° F. and covered with a clean piece of muslin. In about 24 to 36 hours the milk should be curdled by the lactic acid. If this milk is found to have the pleasant acid flavor that is desired it should be added directly to cream or it may be used to prepare a larger quantity of starter; it should be used as soon as it coagulates and before the curd becomes firm. If it coagulates before it is needed it should be cooled to about 55° F. The preparation of a larger quantity of starter is accomplished by sterilizing as much skim milk as is wanted by heating it for an hour to at least 180° F. and then cooling it to about 70° F. The curdled sour milk is then added

to the sterilized skim milk and the whole is kept at a temperature of about 70° F. The bacteria in the sour milk have a clear field in the sterilized skim milk and a good starter is thus obtained. This may be added to the cream for ripening, as explained later. A small quantity of the starter is saved each time and added to another quantity of sterilized skim milk. In this way, provided care is taken to avoid contamination, starters can be carried along for several weeks, and in some cases for months. Whenever starter loses its desirable flavor and aroma, recourse should be had to the original method of obtaining it.

To save time and trouble in preparing a starter by the method just described, it is possible to purchase a pure culture of lactic-acid bacilli. Such a culture prepared for market is known as a commercial starter. In preparing starter from a commercial starter, thoroughly pasteurized skim milk is used. Full directions for making and using such starters always accompany the cultures.

When a sufficient quantity of cream has been gathered for a churning, it should be placed in a vat or can where it can be kept at a fairly uniform temperature, which should be about 70° F. in winter and 65° F. in summer. To the cream should be added about 10 per cent. of starter—that is, a quantity equal to 10 per cent. of the quantity of cream—and the whole should then be thoroughly stirred. The stirring should be continued at occasional intervals for about 3 or 4 hours, to insure even ripening. If the cream is allowed to remain still, the skim milk will settle to the bottom of the vat and curdle in a solid mass; later on this curd is broken up and becomes mixed with the cream, and is a common source of white specks in butter. After the cream has become sufficiently sour it should be cooled to about 55° F., as described for cream that has been ripened by the natural method.

DETERMINATION OF ACIDITY IN CREAM

49. For the production of butter of good flavor, it is necessary to stop the ripening process at the proper stage. Butter that is made from overripened cream has a strong flavor and poor keeping qualities, and will not bring a high price on the market. Experienced butter makers are able to determine remarkably well by the taste, aroma, and appearance of cream when it has reached the proper stage of acidity for churning. It is difficult to describe a standard for these qualities that will be understood by all, as ideas differ concerning what constitutes mildly sour, sour, or very sour cream. As a general statement, however, cream is at the best stage for churning when it is mildly sour, has a mild, pleasant acid aroma, and appears glossy. It is better to churn cream when it is slightly underripe than when it is overripe.

For accurate mathematical calculation of the percentage of acid in cream, various chemical tests have been devised, the most common of which are Manns's acid test and Farrington's alkaline test. Both of these tests are in wide use by commercial creameries, and are suitable for use in the making of butter on farms, provided the butter maker is willing to exercise care in making the tests and in calculating the percentage of acidity. The manipulation of both tests is much the same, but the apparatus differs somewhat. In both tests, an alkaline solution of known strength is added to a definite quantity of cream until the alkali neutralizes the acid in the cream. The quantity of alkali that is necessary to do this measures the quantity of acid present. In order to determine just when the right point is reached and all the acid is neutralized, a coloring matter called an indicator is used; the indicator is pink in an alkaline solution and colorless in an acid solution. In Manns's test, the indicator is added to the cream; in the Farrington test, it is added to the alkali. As the alkaline solution is slowly added to the sour cream in the presence of the indicator, no color is apparent until the point of neutrality is slightly passed. At this stage a pink color gradually appears.

50. Manns's Acid Test.—The apparatus required for Manns's test is illustrated in Fig. 29. The glass burrette is filled to the zero mark with a tenth-normal solution of either potassium hydroxide or sodium hydroxide. These solutions can be made up cheaply by druggists or they can be purchased from dealers in dairy supplies. For this test, 50 cubic centimeters of cream is required. The cream is measured by drawing it into the glass pipette with the mouth until the etched mark in the upper end is reached. This sample of cream is then allowed to run into the glass beaker standing under the burette. To the cream is added a few drops of an indicator—phenolphthalein. The pinch cock at the lower end of the burette is gently squeezed together and the alkali is permitted to drop slowly into the cream. This mixture is stirred constantly with the glass stirring rod until a pink color is faintly noticeable, when the pinch cock should be released. The number of cubic centimeters of alkali that were required to neutralize the acid can be determined from the calibration on the burette. The per cent. of acid in the sample of cream is calculated by multiplying the number of cubic centimeters of alkali that was used by .009, dividing the product by the number of cubic centimeters of the sample, and multiplying by 100. This is expressed in clearer form in the following formula:

$$\text{Per cent. of acidity} = \frac{\text{c. c. alkali} \times .009}{\text{c. c. sample}} \times 100$$

Thus, if 30 cubic centimeters of alkali is required to produce a pink color in 50 cubic centimeters of cream, the per cent. of acid in the cream is

$$\frac{30 \times .009}{50} \times 100 = .54 \text{ per cent.}$$

51. Farrington's Alkaline Test.—The apparatus for making the Farrington alkaline test is shown in Fig. 30; it consists of one or more cylinders of a capacity of 100 cubic centimeters, a pipette of a capacity of 17.6 cubic centimeters, and a white porcelain cup. Clean, soft water to the amount

of 97 cubic centimeters is placed in one cylinder and five alkaline tablets are dissolved in it; these tablets can be purchased cheaply from dairy-supply dealers. The cylinders should be tightly corked and laid away until the tablets are entirely dissolved. If tablets and water are put in the cylinder in the evening, the solution should be ready for use the next morning. Several cylinders of solution can be prepared at one time for convenience, if desired. In making the test, 17.6 cubic centimeters of cream are measured by means of the pipette and the sample is transferred to the porcelain cup. The pipette should be rinsed out with a small quantity of clean water and the rinsings added to the cream in the cup. A few cubic centimeters of alkali are then poured into the cream, the cup being given a rotary motion with the hand, to thoroughly mix the solution with the cream. Then a few drops should be added at a time until a faint pinkish color appears. The number of cubic centimeters of alkali used in neutralizing the acid in the cream is read directly from the calibrations on the cylinder or cylinders, and this number, by pointing it off into two places, expresses the per cent. of acid in the cream. For example, if 56 cubic centimeters of alkali were used the acidity would be .56 per cent.

The per cent. of acid to develop in cream for farm butter making should be from about .50 to .55 per cent.

CHURNING

CONDITIONS AFFECTING CHURNABILITY OF CREAM

52. Temperature.—The temperature of cream at the time of churning is one of the most important factors in determining its churnability. Cream at a high temperature can be churned in less time than is required for cream of low temperature, but an inferior grade of butter will be produced. Likewise, too low a temperature is not desirable, because it retards the process of churning. Under average farm con-

ditions, the best churning temperature of cream is between 55° and 62° F., the exact temperature depending largely on the hardness of the fat, which varies according to the season of the year, the individuality of the cow, the stage of the lactation period, and the kind of feed given to the cows. In spring, cows yield milk containing a larger per cent. of soft fats than at any other time, consequently churning can be done at a lower temperature than in winter, when the harder fats are present in large quantities. Cream produced from the milk of certain individual cows or from the cows of certain breeds can be churned at lower temperatures than that from other individual cows or from cows of certain other breeds. The farther advanced a cow is in the period of lactation the harder will be the butter fat yielded by her milk. Also, succulent feeds tend to produce softer butter fats than do dry feeds. Thus, it can be seen that the best churning temperature of cream varies with conditions. The butter maker should choose some temperature between those already given and vary it according to the preceding conditions. As a rule, about 60° to 62° F. will be found a good winter churning temperature and from about 55° to 58° F. a good temperature for summer churning.

53. Richness.—The quantity of fat in cream is another important factor influencing its churnability. Within certain limits, the more fat there is in a given quantity of cream the shorter the period required for its churning, and vice versa. Of course, cream can become so thick that it will adhere to the sides of the churn and thus not be subjected to agitation. If rich cream is churned at a high temperature the butter is likely to be greasy in texture and will contain considerable buttermilk that is difficult to remove by washing. For farm butter making, it is advisable to produce a grade of cream that contains from about 22 to 28 per cent. of fat.

54. Degree of Ripeness.—As a rule, the riper cream is the easier it will churn. As explained before, the acid produced in the ripening of cream affects the albuminous and caseous matter, making it less viscous; thus, it can be seen

that the greater the per cent. of acid in cream the greater the ease with which it can be churned. However, cream should not be ripened too much or the curd will become coagulated, and when the cream is churned this curd will break up into small lumps and be incorporated in the butter. The proper stage to ripen cream for churning has already been explained.

55. Size of Fat Globules.—The size of the fat globules in cream influences its churnability somewhat; the larger the fat globules the easier the churning, as a general rule. However, this is an unimportant factor in butter making, because the dairyman cannot control such qualities in the cream.

56. Quantity of Cream in the Churn.—The length of time required for completing the churning operation depends to a considerable extent on the quantity of cream in the churn. The greatest churning efficiency is secured when the churn is about one-third full of cream, because, under such conditions, the cream is subjected to the maximum degree of agitation. It is sometimes desirable, however, to have more than this quantity of cream in the churn, and it is possible to churn without much difficulty when the churn is half full. Churn manufacturers usually list the cream capacity of their churns at about half the total capacity.

57. Nature of Agitation.—The kind and degree of agitation given the cream by a particular churn is a factor influencing churnability. In the dash churn, for instance, the cream is exposed to a relatively small degree of agitation, consequently the churning period is considerably longer than for the revolving and swinging types of churns. The speed of operating the churn also affects the churnability of the cream. In the revolving type of churn, for example, if the speed is too great, the cream will be affected by centrifugal force and agitation will not take place to an efficient degree.

OPERATIONS OF CHURNING

58. Preparation of Churn.—The first step in preparing the churn for churning is to rinse it out thoroughly with hot water. A convenient way to do this is to fill the churn about one-third full of boiling water and operate it for a few minutes until the outside becomes warm. In the case of churns having tight-fitting lids, it is necessary to open the vent after a few strokes or revolutions to relieve the pressure generated inside by the hot air and steam; most hand-power churns are provided with a bung or other device for relieving the pressure, and mechanical-power churns usually have provisions for operating the churn during the washing process with the vent slightly open. The next step in the preparation is to let the hot water out and to fill the churn again with cold water. This should be churned until the outside of the churn feels entirely cool to the touch. The use of cold water closes the pores of the wood again and the churn is ready for the cream.

59. Straining of Cream.—As the cream is transferred from the ripening can or vat to the churn, it should be strained through a finely perforated tin strainer suspended in or held above the churn opening. The purpose of this final straining is not so much to remove foreign matter as to break up as much as possible any lumps of curd that may have formed in the cream and which, if not removed, would be incorporated in the butter.

60. Addition of Butter Color.—If the butter maker wishes to produce butter of a uniform color throughout the year, it will be necessary to add artificial coloring matter to the cream previous to churning. The exact quantity of color to add depends on the season of the year and the butter market to be reached. In May and June, it is likely that no color will be needed, as the cows will be feeding on green pastures. But as the summer advances the butter will become lighter in color, and, at times, especially in the winter, it will become so light that artificial color is necessary. Southern markets demand a richly colored butter; Chicago and New

York markets perfer what is known as a "June color," or that characterizing the butter produced during the month of June.

Commercial butter-coloring matter is made from the fruit of the annato tree, from certain vegetables, and from coal tar. All of these colors are satisfactory as coloring matter, but some states have laws forbidding the use of coal-tar butter-coloring material; hence, the butter maker should become informed concerning this matter before using a coal-tar color.

No definite instructions can be given in regard to the quantity of butter color to add, owing to the foregoing conditions. As a rule, about 12 to 20 drops of coloring matter for each estimated pound of butter is used. By a little experimenting, the butter maker can soon learn the proper quantity of color to use under various conditions. Of course, if the quantity of butter fat contained in the cream has not been determined by the Babcock test, there is no way of calculating the quantity of color necessary, and in this case there is nothing to do but to guess at the quantity to use. In case the color is not added to the cream previous to churning, it can be mixed with the salt and added at the time of salting and working the butter, but so much working is necessary to incorporate the color into the butter by this method that the texture of the latter is likely to be damaged.

61. Operation of Churns.—After adding the butter color, the lid of the churn should be clamped down and the churn started. Specific directions for the mechanical operation of each type of churn should be obtained from the manufacturer. After about a minute of churning, the churn should be stopped and the vent slightly opened to relieve the pressure of air within, due to the escape of air incorporated in the cream during the various processes leading up to churning. This should be repeated at intervals of from 2 to 4 minutes until no gas escapes when the vent is opened. The churning should be continued without interruption until the operation is completed. At certain seasons of the year, especially in the fall, when cows are well advanced in the period of lactation, the

churning is frequently difficult. This is due to the fact that under such conditions the fat globules in the cream are exceptionally small and hard and consequently hard to unite. As previously explained, cream subjected to such conditions should be ripened to a greater degree of acidity and churned at a higher temperature than cream not subjected to such conditions. If this fails to correct the difficulty and the cream becomes frothy in the churn, it is advisable to pour warm water over the outside of the latter until the temperature is considerably raised. If this fails to accomplish the desired result, it will be necessary to pour warm water into the churn to break up the mass it contains. Churning under normal conditions is usually completed in from about 20 to 30 minutes.

62. Time to Stop Churning.—There are various ways of ascertaining when the churning has gone far enough. Perhaps the most reliable method is to stop the churn and examine the butter granules, which should be about the size of corn kernels or slightly smaller. If the granules are too small when the churning is stopped, many of them will go through the strainer in drawing off the buttermilk; if, on the other hand, they are too large, a considerable quantity of buttermilk will have become incorporated in the butter.

In the revolving and swinging types of churns, a small glass is fastened in one end of the churn or in the lid so that the operator can see when the cream has broken; so long as this glass is clouded with milk there is no need to examine the cream, but as soon as the glass is washed clear the churn should be stopped for an examination. After the cream has broken, the fat granules unite very rapidly; hence, it is advisable to examine them every three or four revolutions or strokes of the churn.

63. Washing of Butter.—When the butter granules are the right size, the buttermilk should be drawn off through a strainer, the churn filled with about as much pure, cold water as there was cream to start with, the lid clamped on and from six to twelve agitations given to the butter, depending on the

type of churn; if a revolving churn is used, about eight revolutions should be given; if a swing or dash churn is used, about twelve complete swings or strokes are necessary. The wash water should be drained off through a strainer.

Care should be taken to use the purest water obtainable for washing butter, to avoid a possibility of contamination by disease germs or objectionable odors. The wash water should be at about the temperature of the buttermilk, provided the butter has come through in good condition. If the butter comes soft, it is advisable to use water of a slightly lower temperature; if too hard, the temperature should be higher. Extremes should be avoided in all cases, as too warm water will cause a soft, greasy butter, and too cold water will make the butter appear brittle and tallowy, and there will be difficulty in getting the salt incorporated.

64. Washing of Churn.—After the butter and buttermilk have been removed from the churn, it should be thoroughly washed. It is advisable to fill it about one-third full of hot water to which a few handfuls of washing soda has been added, and then operate it for a few minutes until the exterior has become warm. In this condition the pores of the wood are open and it is possible to cleanse thoroughly both the inside and the outside. Scrubbing brushes should be used and care exercised to reach all parts of the interior. After this washing, the warm water should be drained out and replaced by cold water. The churn should then be operated for a few minutes and the water left in it until the wood becomes cool.

SALTING, WORKING, AND PACKING OF BUTTER

SALTING OF BUTTER

65. Purposes in Salting of Butter.—Perhaps the chief purpose in the salting of butter is to give it a desirable flavor. Butter without salt has a flattish, insipid flavor and can be sold only in certain European countries. On the other hand, if too much salt is used the natural flavor of the butter will

be lost. American markets demand a relatively high-salted butter; European markets favor butter that is salted very lightly or, in some cases, not at all. It is important that butter should be salted uniformly from churning to churning. Even a slight variation in the percentage of salt used will cause considerable difference in the flavor.

Another purpose in salting butter is to improve its keeping qualities. It is a well-established fact that common salt is an antiseptic; consequently, when it becomes incorporated in a product like butter, many undesirable ferments that would cause the butter to deteriorate very rapidly are held in check. Salt also indirectly improves the keeping quality of butter by facilitating the removal of buttermilk. This is due to the fact that salt precipitates the curd in the buttermilk, thus releasing the whey, which can be readily removed by working the butter. If the butter has not been thoroughly washed, it is likely to retain an excessive quantity of curd after being salted.

66. Quantity of Salt to Use.—As stated before, the exact quantity of salt to use will depend on the demands of consumers. Under normal conditions of the butter, it is advisable to add about 1 ounce of salt to each pound of butter. However, the butter maker should be governed in his estimate of the quantity of salt to use by certain conditions. If there is a considerable quantity of free moisture in the butter, or if it has a bad aroma, a greasy texture, or small hard granules, it is best to use about $1\frac{1}{4}$ ounces of salt to each pound of butter. Where the butter is not weighed but the quantity is estimated by means of the Babcock test, $1\frac{1}{2}$ ounces of salt per pound of butter fat should be used, because more butter will be produced than is indicated by the test.

67. Method of Salting Butter.—When a common, hand-power churn is used, the butter should be removed from the churn and placed on the worker before the salt is added. It is advisable to spread the butter out somewhat in order to distribute the salt over a wider surface. The next step is to work the salt into the butter, tasting the latter occasionally

to determine when the salt has become thoroughly dissolved.

In case a combined churn and worker is used, as is the case in practically all creameries and on exceptionally large dairy farms, the salt is added to the butter while it is still in the churn and the working is done mechanically by rollers operated by the churn gears. Specific directions for this operation, of course, accompany the churn.

WORKING OF BUTTER

68. Purposes in Working of Butter.—The chief purpose in the working of butter is to distribute the salt evenly through it. No matter what the condition of the butter may be, working should not be stopped until all the salt has been dissolved and the entire mass of butter has a uniformly salty taste. Another purpose in the working of butter is to get rid of the excess of buttermilk and water it contains. If this were not done the butter would have a poor flavor and would rapidly deteriorate. A third purpose in the working of butter is to bring it into a compact, waxy mass and give it texture.

69. Methods of Working Butter.—The most common method of working butter on the farm is by the wooden-bowl-and-ladle method; that is, the butter is placed in a wooden bowl and worked with a wooden ladle. This method involves considerable muscular exertion, is inefficient, and usually destroys the texture of the butter; consequently, it is not to be recommended even for small quantities of butter. The butter maker should not spare a reasonable expense in providing an efficient butter worker, for the lessened labor and improved quality of butter resulting from its use will more than repay the outlay.

In the working of butter, either with a hand or a machine worker, the operator must be guided by the condition of the butter. Hard, granular butter should be worked longer than soft, waxy butter, and butter of a poor flavor requires more working than that of good flavor. Of course, the principal

guide of the butter makers should be the evenness of salt distribution, as determined by tasting the butter at frequent intervals. After the salt has become thoroughly distributed, a good plan is to scrape the forefinger over the top or the side of the mass so as to gather up a lump of butter about the size of a hazelnut; if the butter in the lump breaks away from the main mass leaving long thread-like projections at the edge, the texture is as good as can be obtained and it is best to stop working. If the butter does not break away with threads, it is best to work it for 1 or 2 minutes longer and make the test again. However, an exceptionally soft grade of butter will never show threads, no matter how much it is worked. Slow, careful working is advised under all conditions.

In the combined churns and workers, each particular type requires a different number of revolutions for the working of butter. The manufacturer's instructions should be followed as nearly as possible, but the foregoing tests should also be made.

PACKING OF BUTTER

70. Importance of Proper Packing.—It is almost axiomatic to state that any article of food must be put up in a sanitary and attractive package to bring the highest market price. This statement is especially true of butter, which is easily contaminated by dust and bad odors. The primitive practice of printing butter in elaborately carved molds that are difficult to keep clean, and later selling it absolutely unprotected by any sort of covering or package, is to be severely condemned. If butter is to command a good price it must be wrapped or boxed in such a way that there is no possibility of contamination from without. This is not only a matter of business to the dairyman but is a strong movement in the direction of pure food.

71. Kind of Package to Use.—The kind of package to use depends on the quantity of butter produced and on the demands of the consumer. It is obvious that when but a few pounds of butter are made each week the use of tubs or crates

is out of the question. Also, if the butter is sold to private customers, it is not likely that a package holding more than 1 pound will be in demand. When large quantities are produced, it may be found that packing in tubs is the most economical method to follow, although, in most markets, the small package commands the highest price.

For the average farm, where from 5 to 100 pounds of butter is produced each week, there is perhaps no better method of packing the butter than to print it in 1-pound, brick-shaped, prints, and wrap these in one of the commercial vegetable-parchment papers sold by dealers in dairy supplies. This makes a sanitary and attractive package, and if the butter-maker's name and address or some appropriate trade mark is printed on the wrapper, considerable advertising will be derived from it. A step in advance of this is to place the wrapped package in a pasteboard carton, such as the one shown in Fig. 35.

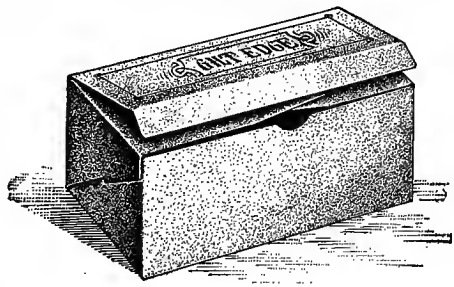


FIG. 35

This is simply a pasteboard box made to hold one print of butter, and it usually bears advertising matter relative to the butter it contains. Butter packed in either vegetable-parchment paper or cartons can be handled to much better advantage in hauling or shipping, and it is practically secure against contaminating influences. It is safe to say that good butter packed in this way will command a price sufficient to cover the cost of the wrappers, with a margin of profit, over that sold in bulk or in uncovered prints.

Some markets prefer the large packages, such as tubs and round boxes holding from 5 to 60 pounds of butter. A few markets prefer a package made of a particular kind of wood; for instance, the Boston market gives preference to butter packed in a spruce tub. In Fig. 36 (*a*) is shown a popular type of butter tub; in (*b*) is shown a round butter box and a

crate made to hold twelve 5-pound boxes. These tubs and boxes are provided with metallic fasteners that can be easily

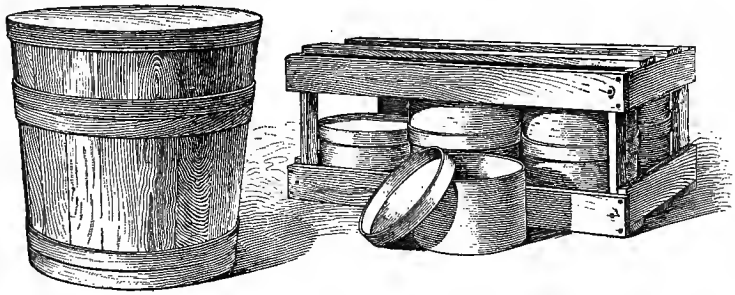


FIG. 36

tacked on to the lid and sides when the packages are filled.

For the shipping of butter short distances in warm weather, when there is danger of the butter becoming soft or rancid, the returnable refrigerator shipping box is desirable. One form of the refrigerator box with trays is shown in Fig. 37. It requires no ice, being constructed with dead-air spaces around the box.

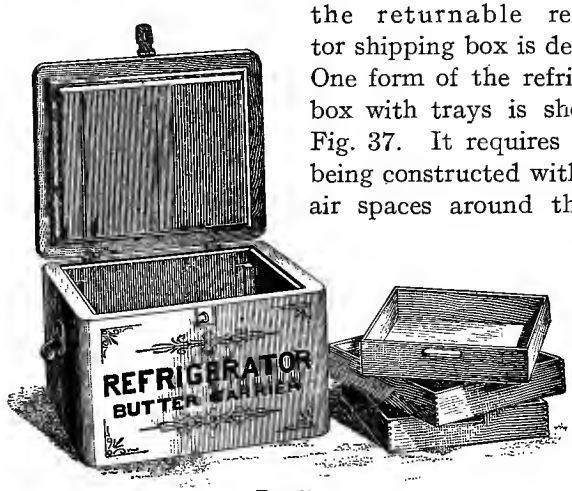


FIG. 37

Such boxes can be purchased in sizes ranging from about 15 to 80 pounds capacity. Boxes equipped for packing the butter with ice for shipment over a long distance can be purchased in sizes from about 12 to 120 pounds capacity.

BEEF AND DUAL-PURPOSE CATTLE

(PART 1)

DEFINITIONS AND EXPLANATIONS

1. **Beef cattle** are cattle that are kept primarily for the production of beef, thus contrasting them with dairy cattle, which are raised primarily for the production of milk.

2. **Dual-purpose cattle** are cattle that are kept for the production of both beef and milk. An appropriate term for them and one that is commonly applied is *general-purpose cattle.* They produce, when fattened, fairly satisfactory carcasses of beef, although they are not the equal of the special-purpose beef cattle in this respect, and the cows give a sufficient quantity of milk of fair butter-fat content to warrant milking them. If cattle of a dual-purpose breed or strain possess merit as beef animals but are without dairy qualities, they should be classed as beef cattle. If, on the other hand, they possess dairy qualities but neither they nor their offspring exhibit beef qualities, they should be classed as special-purpose dairy cattle.

3. In describing beef and dual-purpose cattle, it is necessary, as is true in the case of all kinds of livestock, to make use of certain technical terms, the meaning of which would, without explanation, doubtless be clear to stockmen but not to inexperienced persons. These terms are: *form*, or *conformation*, *quality*, *constitution*, and *early maturity*.

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

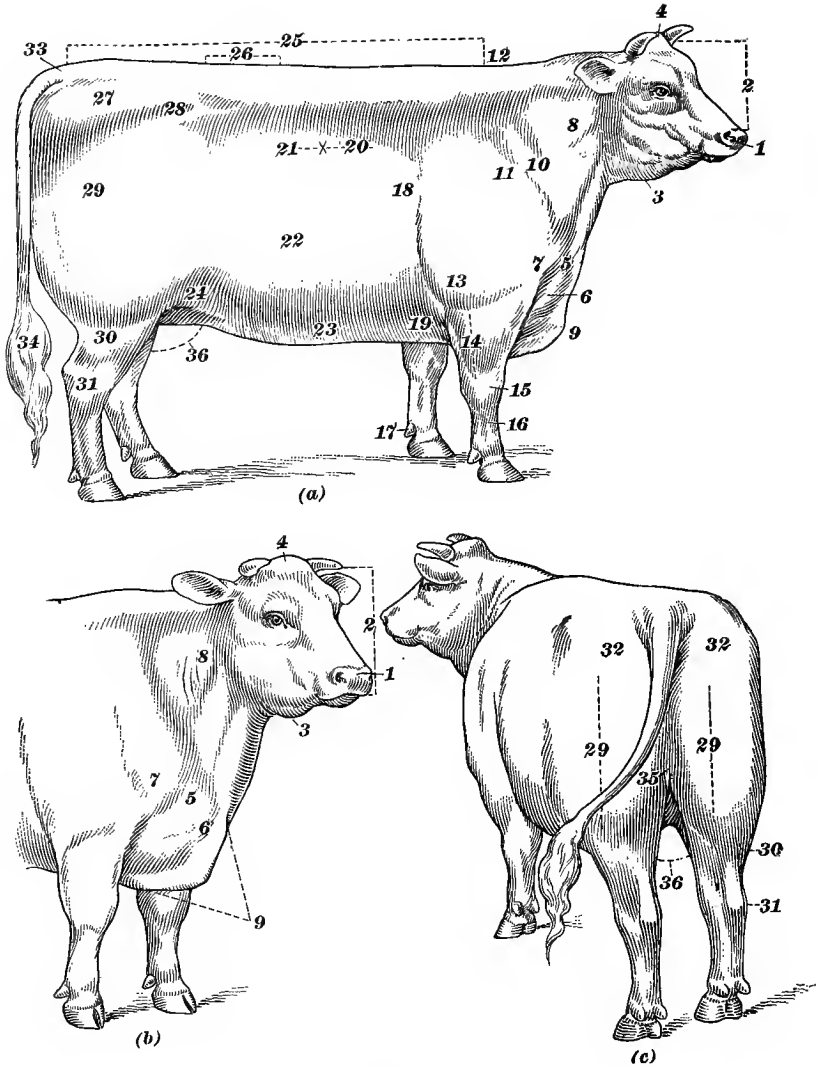

4
33
25
26
12
2
27
28
8
1
21
20
11
10
29
18
3
22
7
5
13
6
24
19
9
34
30
23
14
36
31
15
17
16
(a)
4
2
8
1
6
3
7
5
6
9
(b)
32
32
29
29
35
30
36
31
(c)

FIG. 1

4. By **form,** or **conformation,** is meant the outward visible shape of an animal. It has particular reference to the relative straightness of the top line and bottom line, the depth and breadth of the body, and the compactness and symmetry of the parts as a whole. When a cattleman states that a steer has a desirable conformation, he means that the top line and bottom line of the animal are comparatively straight, that its body is deep and broad, and that, as a whole, the animal is low-set, compact, and symmetrical.

NAMES OF EXTERIOR REGIONS SHOWN IN FIG. 1

1, Muzzle
2, Face
3, Tongue fat (feeder's wattle)
4, Poll
5, Breast
6, Brisket
7, Shoulder point
8, Neck
9, Dewlap
10, Shoulder vein
11, Shoulder
12, Withers
13, Elbow
14, Arm
15, Knee
16, Cannon
17, Dew claws
18, Crops
19, Fore flank
20, Fore ribs
21, Midribs
22, Barrel
23, Belly
24, Hind flank
25, Back
26, Loin
27, Rump
28, Hooks
29, Thighs
30, Gaskins
31, Hocks
32, Pin bones
33, Tail head
34, Switch
35, Twist
36, Udder in cows; cod in steers; scrotum, or purse, in bulls.

5. Quality, as used by stockmen, refers to the relative fineness of structure of an animal. Quality is indicated by fine hair; loose and pliable skin; an even covering of firm, mellow flesh; fine but strong bone; a clean-cut head that is free from coarseness; refined but not delicate features; a stylish appearance; and, in fact, general refinement throughout.

6. By **constitution** is meant the aggregate of the physical powers of an animal. Thus, an animal that has a strong constitution has strong physical powers and consequently is able to withstand an unfavorable environment to a greater degree than an animal of weak constitution. Strong consti-

tution is evidenced by a large heart girth, a capacious chest, a roomy but not paunchy barrel, a well-developed brisket, deep flanks, and strong bone. In order for an animal to have a strong constitution, there must be plenty of room for the vital organs and general strength and vigor of the parts as a whole.

7. Early maturity is a term used to express the potential quality of an animal to reach a desired condition at an early age. For example, a beef animal is said to possess the quality of early maturity if it can be made sufficiently fat to satisfy market requirements when it is 18 months old or under. If a beef animal cannot be satisfactorily fattened for the market until it is 2 years old or over, it is called a late-maturing animal. Some of the indications of early maturity in a beef animal are: a tendency to grow rapidly, to lay on fat readily, and to be low-set, or short legged, and free from coarseness and angularity. In other words, an animal that possesses quality without tending to be delicate, or weak in constitution, will usually mature early. A late-maturing animal, on the other hand, shows a disproportionate length of leg, general coarseness and angularity, and a lack of tendency to fatten into a satisfactory market animal.

8. Parts of Cattle.—In describing beef and dual-purpose cattle, it is necessary to mention various parts and regions of the body. The location of all of the parts and exterior regions about which doubt might arise is shown in Fig. 1. In (*a*) is shown a profile view of an animal; in (*b*), a front view; and in (*c*), a rear view. The names of the different regions shown are given on the page opposite the illustration.

BEEF AND DUAL-PURPOSE TYPES OF CATTLE

BEEF TYPE

9. Cattle that have the desired conformation for beef production are said to be of the **beef type.** It is not difficult to describe this type in such a way that the description will be applicable to cattle that have been fattened for market, but it is not so easy to give a description that will apply to cattle in thin condition, such as feeders before they have taken on any fat. This is because beef conformation is somewhat of a potential quality; that is, it is not strongly developed in most beef animals until they become fat. The experienced cattleman is able to distinguish animals of the beef type, even though they are in thin condition, but the inexperienced person often has difficulty in doing this. There are certain characteristics, however, that are invariably associated, to a greater or less degree, with cattle of this type.

An animal of the correct beef type has a compact form. It is short in the neck and legs, and has a broad, short head; well-sprung ribs; a deep, broad chest; well-laid-in shoulders and hips; a long, level rump; and well-fleshed thighs. The top line and bottom line are approximately straight and parallel. In general, a beef-type animal has a high percentage of meat to bone and offal. In Figs. 2 and 3 are shown animals of the approved beef type.

Animals of the beef type invariably show marked indications of having a high percentage of the blood of one or more of the recognized improved breeds of beef cattle. The breeds that are classed as beef breeds are: the *Shorthorn*, the *Polled Durham*, the *Hereford*, the *Aberdeen-Angus*, the *Galloway*, and the *Sussex*.

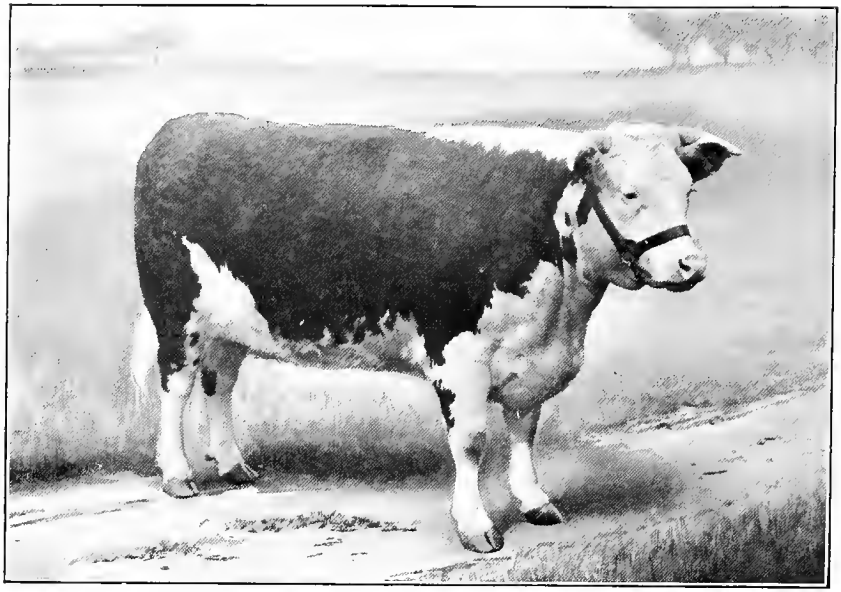


FIG. 2

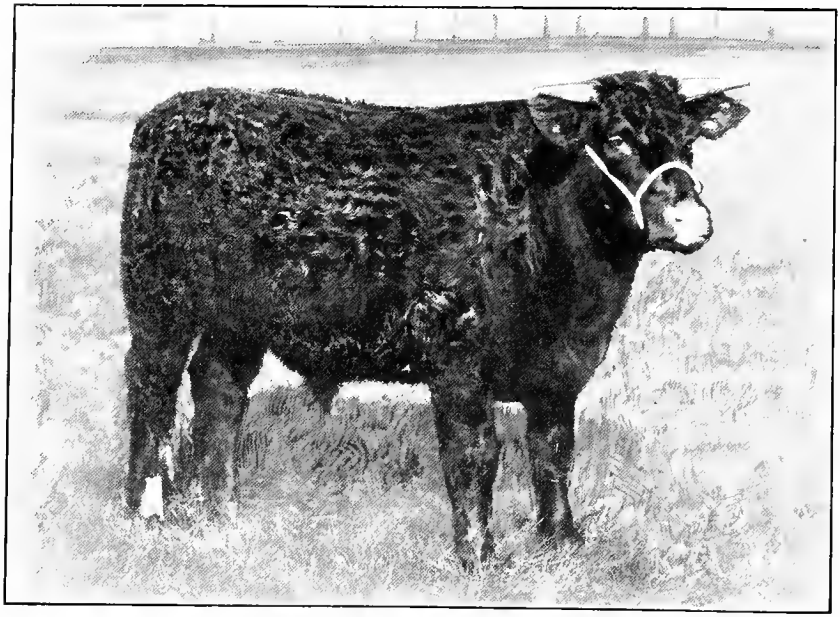


FIG. 3

DUAL-PURPOSE TYPE

10. Cattle that closely approach the beef type without sacrificing to any great extent dairy excellence are said to be of the **dual-purpose type.** There is considerable difference of opinion, however, in regard to just what characters should be found in cattle of this type, some authorities insisting on marked beef-type characters and others on pronounced dairy-type characters. An animal of the dual-purpose type should not possess the characteristic angularity of the special-purpose dairy cattle, but should show marked ability to take on flesh and fat; this is especially true in the case of males and of cows that are not in milk. On the other hand, cows should show pronounced indications of ability to give a reasonably good flow of milk. The udder and teats should be well developed and free from fleshiness; that is, they should be loose, mellow, and pliable to the touch. When a cow of the dual-purpose type is milked dry, the udder should be greatly reduced in size; in cows of the beef type the udder is fleshy and is about the same size after milking as before.

In comparing an animal of the dual-purpose type with one of the beef type, it may be said that the dual-purpose animal has a greater length of neck and head, a less pronounced tendency toward fleshiness and fattening qualities, and gives considerably more evidence of an ability to produce milk in adequate quantities. In Figs. 4 and 5 are shown animals of the correct dual-purpose type. The animal shown in Fig. 4 borders on the dairy type; the one in Fig. 5 borders on the beef type.

The dual-purpose type of animal is not restricted to any particular breeds, but because a large number of animals of certain breeds are of this type, the breeds are spoken of as dual-purpose breeds. These breeds are: the *Devon*, the *Red Polled*, and the *Brown Swiss*; certain animals and strains of the *Shorthorn* breed are also classed as dual purpose.

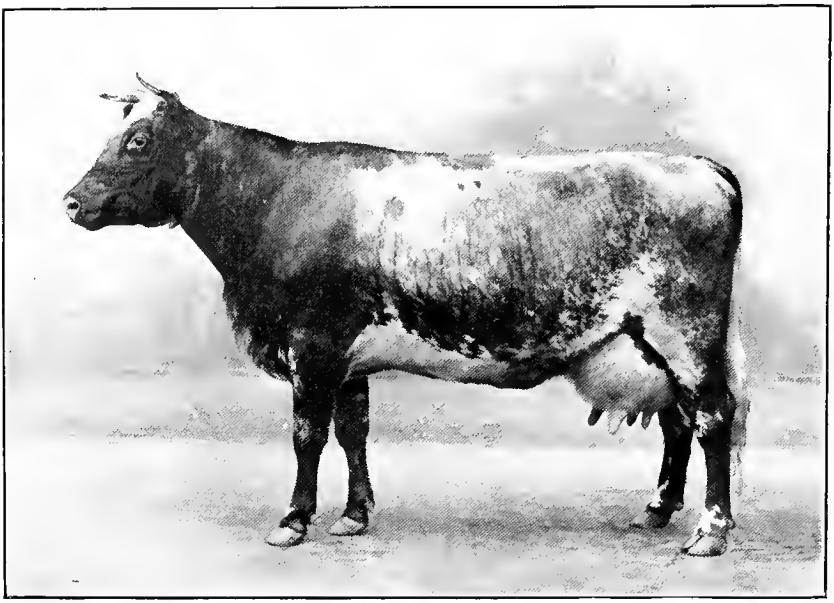


FIG. 4

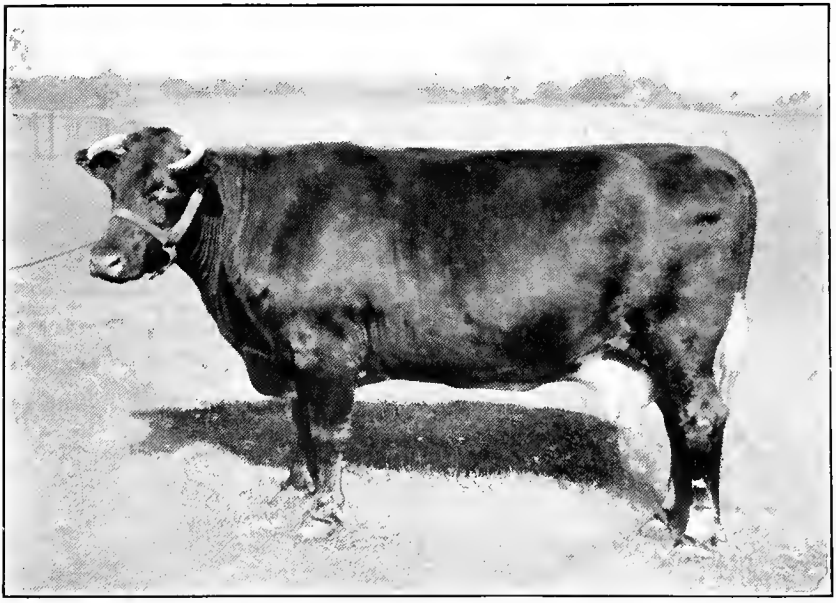


FIG. 5

BEEF AND DUAL-PURPOSE BREEDS OF CATTLE

BEEF BREEDS

SHORTHORN CATTLE

11. Origin and Development.—The **Shorthorn breed** of cattle originated in the northeastern part of England, along the valley of the river Tees and in the counties of Northumberland, Durham, York, and Lincoln. For many years the Shorthorns were known as Durham or as Teeswater cattle. The exact origin of the breed is somewhat obscure, but it is known that it is the result of the blending of several types of cattle that existed in the region just mentioned. Little is known of the appearance of the foundation stock prior to the 17th century. During that century, the Pied cattle of Lincolnshire, which are described as being more white than any other color, and the red cattle of Gloucestershire and Somersetshire intermingled. It is claimed that the Holderness cattle of Yorkshire also entered into this mixed breed. The Holderness cattle are said to have been black and red in color, large bodied, short horned, and profitable to both the dairyman and the butcher. By the early part of the 18th century these different races, or strains, of cattle were blended into one common stock, from which the Shorthorn breed has descended. Although disputed by some authorities, it is probable that at about the middle of the 18th century Dutch or Flanders cattle imported from Holland were crossed with the foundation stock. Since 1780, accurate records have been kept and the improvement of the breed from that time has been made mainly by the selection of desirable animals within the breed.

12. In the development of the Shorthorn breed, the names of certain of the early English and Scotch breeders stand out preeminently. Charles Colling, Sr., a noted breeder, was an advocate of the in-and-in system of breeding, and bred the cow Cherry, which is now considered the foundation of the improved type of Shorthorn. He turned his business over to his sons Robert and Charles. Robert Colling owned the noted bull Hubback, which was small, yellowish-red in color, and had considerable quality, proving to be a successful cross on the large, late-maturing cows that were common at that time. A noted bull that descended from Hubback was Favorite (262), which sired Comet (155), the first bull to sell for $5,000. The Collings founded the Phoenix, the Wildair, the Princess, the Red Rose, the Bright Eyes, and the Daisy tribes, or families, and some others.

Thomas Booth, of Killerby, and his sons Richard and John were among the most noted of the early Shorthorn breeders. The Booths bred their cattle along much the same lines as those followed by the Collings. Some of the noted families of Shorthorns bred by the Booths are: the Farewell, the Broughton, the Dairy Maid, or Moss Rose, the Gaudy, or Lady Betty, the Mantilinia, and the Belinda. The most famous bull used by the Booths was Crown Prince (10,087).

Thomas Bates, of Kirklevington, was another famous breeder of Shorthorns. Bates paid especial attention to pedigree and to milking qualities. The Bates strain of Shorthorns was at one time the most popular strain of the breed, and prices were obtained for Bates Shorthorns that have never been obtained for the cattle of any other line of breeding. Bates's particular tribe was the Duchess. A cow of this family sold for $40,600 at a sale in 1873. The bull Belvedere (1,706) and his son Duke of Northumberland (1,940) were two of the best animals ever produced by Bates.

Amos Cruickshank was a noted Scotch breeder of Shorthorns. His ideal was a low-set, broad, deep-bodied, thickly fleshed animal. Cruickshank especially emphasized shortness of leg, depth and breadth of chest, length and spring of rib, and good conformation of barrel and quarters. The bull Champion

of England (17,526) was perhaps the greatest breeding bull ever owned by Cruickshank.

13. Introduction Into America.—The first Shorthorns imported into the United States were brought to Virginia in 1783. The cattle of this importation were of two types, the dairy type and the beef type. The colors of the cattle were red, white, red and white, and roan. The dairy-type animals had short horns and compact, heavy bodies, the cows displaying marked dairy propensities. The beef-type animals were longer, more rangy, and later maturing than those of the dairy type, but when mature they attained a large size and made heavy carcasses. In 1785, some of these Shorthorns were taken into Clark County, Kentucky. These cattle, with more of the same stock that were taken into Kentucky during the next decade, effected a marked improvement on the native stock; they became known as "Patton's stock," from the name of the family that owned them.

In 1817, the first Kentucky importations were made. Col. Lewis Sanders imported eight heifers and James Prentice imported two bulls. The descendants of the animals imported by Mr. Sanders became known as the "seventeens." They were excellent individuals and exerted a widespread influence on the Shorthorn stock of Kentucky. In 1822, the roan heifer Arabella was imported by Samuel Williams, of Massachusetts. This animal became the foundation of the Arabella tribe, which was at one time large and highly valued for its dairy qualities. From 1821 to 1833, many important importations were made into a number of states. In 1831, Benjamin Warfield, a noted breeder, secured his first pure-bred Shorthorn. He was succeeded by his son William, who originated the Loudon Duchess family of Shorthorns.

14. The Ohio Importing Company was organized in 1833 for the purpose of promoting the interests of agriculture and introducing an improved breed of cattle. Felix Renick, one of the leading promoters, was sent to England to select cattle for the company. He visited many noted herds and selected seven bulls and twelve females for the first importation. This

importation proved very successful, and in 1835 and 1836 two more importations were made by this company. In 1836, the company held its first sale of forty-three animals, which brought an average of $803.25 per head. The final sale of the company was held in 1837; the fifteen head of cattle that were sold averaged $1,071.65 each.

In 1852, the Scioto Valley Importing Company was organized and through its agents, George Renick and Dr. Arthur Watts, imported ten bulls and seventeen females. This importation sold at auction at an average of $1,351.85 per head, and proved to be a great stimulus to the breeding of Shorthorn cattle, several importing companies being organized.

From 1830 to 1880, several importations of Shorthorns of Bates breeding were made into the eastern part of the United States. Samuel Thorne made perhaps the most important of these importations. From 1860 to 1880, the Bates Shorthorns were very popular in this country. After 1880, the Scotch blood grew rapidly in popularity, and within recent years high prices have been paid for animals having Scotch pedigrees.

15. Description.—The Shorthorn breed has wonderful adaptability, and this quality has led to wide distribution of the animals not only in this country under various conditions, but in nearly every country in which cattle are bred. Shorthorns were the first cattle used for improving the cattle on the ranges, but notwithstanding their value for this purpose, they are best adapted to a system of mixed farming, such as is carried on in the Central States. The Shorthorns are popular in localities where land is high in value, because many of the animals yield a profit in milk as well as in calves.

The Shorthorn may be red, white, red and white, or roan in color. Animals of the breed are the heaviest of the beef cattle, mature bulls often weighing as much as 2,400 pounds. At present the tendency is to breed for early maturity, and as a result present-day Shorthorns are not as large and coarse as they were formerly. The Shorthorn is characterized by great weight and size, together with symmetry and style.

FIG. 6

FIG. 7

A typical Shorthorn cow is shown in Fig. 6 and a bull of the breed in Fig. 7. Both are excellent representatives of the breed.

16. The head should show refinement and good feeding qualities; should be wide between the eyes, short from the eyes to the nostrils, and the face should be slightly dished. The horns should be short, rather fine; should curve forwards; and they should be waxy white in color, with dark tips. The neck should be short and should blend smoothly into the head and shoulders; the shoulders of the Shorthorn are inclined to be bare of flesh. The body, in good animals, is deep and strong in heart girth; the back is broad, straight, level, and deeply covered with flesh; the hindquarters are considered to have the best development to be found in the animals of any breed; the line of the back of the thigh is nearly straight and the flanks are well let down, giving the animals a characteristic squarely built appearance. If fed for a long period the Shorthorn tends to produce patches of fat about the tailhead and rolls of fat along the sides. Shorthorns were formerly criticized for being too long of leg, but since the infusion of the blood of low-set Scotch animals, this tendency has been largely obliterated. Because of the difference in types, there is more or less lack of uniformity in the breed, two distinct types being bred today in the United States: the strictly beef type and the milking type. The Shorthorns are possessed of a quiet disposition and the animals grow rapidly. They require good care and pastures; in fact, they will not thrive unless well cared for and amply fed.

17. Few breeds equal the Shorthorn in the production of beef. The animals are naturally thickly fleshed, with a maximum development of the valuable parts of the carcass; they are not as early maturing as the cattle of some of the other beef breeds, but can easily be made ready for the butcher at from 1 to 2 years of age; they will, however, stand a considerable longer period of feeding, if this is desired; they carry flesh well, and only after being forced in fattening for a long time do they exhibit a tendency to take on flesh unevenly, with fat in patches on the rump or rolls on the sides. The

Shorthorn is a good feeder and makes large gains for the feed consumed. The breed is very popular in the United States, Canada, England, and other countries where beef is produced.

The Shorthorn is the most highly prized of all the breeds for grading up common cattle. A marked improvement has been made wherever the Shorthorn has been used for this purpose; this is particularly true on the western ranges, where Shorthorn bulls have proved their worth in grading up range cattle. The first cross of a Shorthorn on an animal of any other breed produces an excellent beef animal, and grade Shorthorns predominate over all other kinds of animals in American cattle markets. The "Prime Scots," so popular in the English markets, are crosses of the Shorthorn on the Aberdeen-Angus, and the "blue-gray" steers are crosses of light-colored Shorthorns on Galloways.

English breeders of Shorthorns have always paid more or less attention to the milking qualities of their animals; in fact, some English breeders pay as much attention to milking qualities as to beef-producing qualities. But in America, especially since the thickly fleshed Scotch type of Shorthorns became popular, the milking qualities of the breed have been neglected. With the rapid increase in the value of land, however, more attention has been given to the milking qualities, and at present efforts are being made to develop milking strains of Shorthorns, more commonly known as dual-purpose Shorthorns. The milk of the Shorthorn is of good quality, as a rule, and the cows of the breed have made creditable records in butter tests against animals of the leading dairy breeds.

18. Registration.—George Coates, of Yorkshire, England, published the first volume of the Shorthorn Herd Book in 1822, and from this was developed the English Shorthorn Herd Book. Since 1876, the Herd Book has been in the hands of the Shorthorn Society of the United Kingdom of Great Britain and Ireland.

The first volume of the American Shorthorn Herd Book was published in 1846 by Lewis F. Allen, of Black Rock, New York. The publication was continued as a private enterprise until

1882, when it was purchased by the American Shorthorn Breeders' Association. The first volume of a herd book known as the American Shorthorn Record was published in 1869 by A. J. Alexander, of Woodburn, Kentucky. The first volume of the Ohio Shorthorn Record was published in 1878 by the Ohio Shorthorn Breeders' Association. The American Shorthorn Breeders' Association purchased all of the Shorthorn herd books of the United States, and beginning with Vol. 25 of the American Shorthorn Herd Book, started by Mr. Allen, has continued the publication, having charge of the entire registration of Shorthorns in the United States.

The registration of Shorthorns in Canada is conducted by the Dominion Herd Book, which first appeared in 1887, this publication having purchased the interests of the British-American Shorthorn Herd Book and the Canadian Shorthorn Herd Book.

POLLED DURHAM CATTLE

19. Origin and Development.—The **Polled Durham breed** of cattle originated in America, particularly in the Miami Valley of Ohio, and has the distinction of being the only breed of cattle that has originated in this country. The true foundation of the breed, however, dates back to the dawn of the history of domestic cattle in England, for the breed is merely a branch or family of the Shorthorn breed that has been evolved by a number of breeders who conceived the idea of breeding Shorthorns without horns.

Polled Durhams have been developed along two lines, the *single standard* and the *double standard.* The **single-standard** line of breeding had its origin in crosses of Shorthorn bulls on native muley, or hornless, cows. The term single standard is derived from the fact that animals of this line of breeding can be registered only in the American Polled Durham Herd Book. The **double-standard** line of breeding had its inception in what might be termed a freak of nature—the birth of hornless calves from pure-bred Shorthorn parents. The term double standard is derived from the fact that animals of this

strain are eligible to registry in both the American Polled Durham Herd Book and the American Shorthorn Herd Book.

20. The single-standard line of breeding was established between the years 1860 and 1870. During this period several breeders located in widely separated sections, each ignorant of the work of the others, were trying to originate a breed of hornless cattle by crossing pure-bred Shorthorn bulls on native muley cows. The principal breeders engaged in this work were: William W. Crane, of Tippecanoe City, Ohio; W. S. Miller, of Elmore, Ohio; J. F. and A. E. Burleigh, of Mazon, Illinois; and Shafor & Clawson, of Hamilton, Ohio. In discussing the origin of the muley cows that were used as foundation stock, W. S. Miller states that among the cattle brought to this country in early importations there were several varieties of hornless cattle. These hornless cattle, according to Mr. Miller, varied in color and other qualities, and became intermingled in every possible way with other cattle of the country; but no matter with what animals they were crossed, their descendents for hundreds of years persisted in maintaining the hornless character, so that in all parts of the country there can even yet be found muleys among the native cattle. Mr. Miller further states that in nearly every herd of cattle in the country at the time of the founding of the Polled Durham breed a few muleys were to be found; and that compared with other animals of the herds the muleys were uniformly heavier bodied and more blocky, and had every appearance of being better milkers than the horned animals.

The great champion of the single-standard strain was William W. Crane, of Ohio. His method of breeding was to select native muley cows as near to the form desired as possible and breed them to registered Shorthorn bulls. Of this cross only the hornless females were saved. These, in turn, were bred to other Shorthorn bulls, and of the offspring none were saved but the polled females. This line of breeding was continued until the 4th and 5th crosses were reached. After that the polled animals were more or less interbred to fix the characters sought, which were the colors, markings, contours,

and scale of the Shorthorns, to which was added that of hornless heads. The aim was to produce practically pure Shorthorns without horns. This method is much the same as that followed by other leading breeders. It was the desire of the breeders to produce a breed that would be red in color, or nearly so, and for this reason they selected cows that were red. Much attention was given also to the milking qualities of the breed.

21. The double-standard strain of Polled Durhams has descended, as previously stated, from hornless calves having pure Shorthorn blood. Double-standard Polled Durhams have come from three families: the Gwynne, the White Rose, and the Phyllis. The Gwynnes are descended from Oakwood Gwynne 4th, a roan cow bred by W. S. King, of Minneapolis, Minnesota. She had loose horns, or scurs, but produced three calves that were entirely hornless. Bred to 7th Duke of Hillhurst 34,221, she produced in 1881 a pair of twin calves—Mollie Gwynne and Nellie Gwynne—that were hornless. In 1883, Oakwood Gwynne 4th, to the service of Bright Eyes Duke 8th 31,894, produced a polled red bull calf that is recorded as King of Kine 87,412. In 1888, W. S. Miller purchased the two cows Nellie Gwynne and Mollie Gwynne, the bull King of Kine, and two polled heifers Nellie Gwynne 2d and Mollie Gwynne 2d. Only in one instance did King of Kine get a calf with horns, and in that instance the horns were small.

22. The White Rose division of the Polled Durhams came through the famous show bull Young Hamilton 114,169. He was a natural polled animal bred from Shorthorn sire and dam. The Phyllis division of the Polled Durhams descended from Mary Louden, a natural polled cow from Shorthorn parents.

23. Distribution in the United States.—Polled Durhams are found in greatest numbers in Indiana, Iowa, Ohio, Illinois, North Dakota, Kansas, Kentucky, Wisconsin, Texas, and Nebraska, the numbers in these states ranking about as the order named. The breed is growing in favor principally in these states.

FIG. 8

FIG. 9

24. Description.—In size, color, and general appearance, the Polled Durhams are similar to the typical Shorthorn, save that the Polled Durhams are hornless. The preferred and prevailing color is red. The breed is so much like the Shorthorn that no additional description need be given. A rather rough Polled Durham cow is shown in Fig. 8 and an excellent Polled Durham bull in Fig. 9.

The breed is not yet sufficiently strong in numbers and has not been handled enough for dairy purposes to furnish milk records of value. The animals have been from the first, and continue to be, bred primarily for the development of beef qualities as their dominant character, consequently their dairy qualities must be regarded as a secondary consideration. It remains to be determined to what extent the breed will affect the interests of dairymen.

25. Registration.—The American Polled Durham Breeders' Association was organized in Chicago, November 14, 1889, and was chartered November 22, 1890. The association publishes the American Polled Durham Herd Book, the first volume of which appeared in 1894.

HEREFORD CATTLE

26. Origin and Development.—The **Hereford breed** of cattle originated in Herefordshire, England, from which it takes its name. Herefordshire is preeminently a grazing country, the conditions being favorable to a luxuriant growth of grasses. The origin of the Hereford, like that of other English breeds, is obscure. The general opinion among authors, however, is that the breed descended from the aboriginal cattle of the country, from which descended also the Sussex and the Devon breeds, and that the original color of the animals was red. A second point agreed on by various authors is that there was an admixture of the cattle of Wales. The county of Hereford lies next to Wales and it is very probable that in the early development of the breed the Welsh cattle played a prominent part. To these cattle, which were

white with red ears, several writers attribute the white markings of the Hereford. There is good authority that there was also an infusion of the blood of the white-faced cattle of Flanders; some writers attribute the white markings of the Herefords to this cross. Whatever the origin of these markings, they were well established by the latter part of the 18th century.

The early Herefords were very active and tractable, and were highly esteemed by graziers because of their great substance and depth of carcass. They were fairly early maturing, produced a good quantity and quality of beef, and brought high prices. The fact that they were large and of good draft form made them popular, as at that time cattle were raised as much or more for use at the plow and other kinds of labor as for beef and milk production.

27. During the first half of the 19th century the Herefords began to attract considerable attention. The cause of the breed was taken up by the leading graziers, who found no cattle that surpassed the Herefords for profitable feeding on a simple grass ration. Herefords also took a leading position in the show yard, winning more prizes at the early shows than the animals of any other breed. These facts attracted wide attention, and as a result the breed began to extend outside of the county of Hereford. Before 1835, the breed had become established in fifteen English and Welsh counties.

Certain of the early Hereford breeders of England became noted for their work in improving the breed. Of these breeders the Tomkins family has the greatest fame. Through the efforts of this family Herefords gradually matured earlier, produced less offal, and became shorter of leg and more refined in every way. In 1819, the herd of Benjamin Tomkins, consisting of 52 animals, was sold at auction, 28 head of the breeding stock bringing over $20,000. Another noted family of Hereford breeders was the Galliers. They used much the same blood in developing their herd as was used by the Tomkins family.

Early 19th-century Hereford breeders of note were John Price, John Hewer, and Thomas Jeffries. John Price was an advocate of in-and-in breeding and developed a famous herd.

He realized over $83,000 in auction sales of Herefords. John Hewer did much to improve the breed, placing great emphasis on scale, quality, and uniformity of color. He had four favorite strains: the Countess, the Lofty, the Red Rose, and the Fanny. Hewer rented out bulls to service for large sums, and bred and owned many of the most noted Herefords of the 19th century. There is scarcely a line of Hereford breeding today that is not traceable to the Hewer stock. Thomas Jeffries rented bulls from John Hewer to improve his herd. This blending of blood brought about remarkable success and Jeffries produced many famous animals. Cotmore (376), which was bred by Jeffries, is classed as one of the best Hereford bulls of history.

28. Introduction Into America.—The first importation of Herefords into the United States was made in 1817 by Henry Clay, of Lexington, Kentucky. A few other importations followed shortly after but the breed did not make much progress in the United States until about 1840.

The first person to make extensive importations and who, probably, has done more for the breed in the United States than any other person, was William H. Sotham, a native of Herefordshire, England, who had emigrated to New York. In 1839, Mr. Sotham made an importation of Hereford cattle, selling a half interest in them to Erastus Corning, of Albany, New York. In 1840, in connection with Mr. Corning, he made an importation of twenty-one Hereford cows and heifers, and a 2-year-old Hereford bull. In the same year he made another importation of ten Hereford heifers and a bull. For a number of years he exhibited his Herefords at fairs in New York State, Ohio, Missouri, Kentucky, and Pennsylvania, and distributed his stock into all parts of the country. Mr. Sotham was succeeded by his son, T. F. B. Sotham, a prominent advocate of the Herefords in the United States.

In 1860, F. W. Stone, of Guelph, Canada, began the importing and breeding of Herefords, some of his animals subsequently furnishing the foundation for many of the herds in America. About 1875, T. L. Miller, of Beecher, Illinois, made

his first importation. Mr. Miller was one of the greatest promoters of the breed in its early history in this country, owning at one time the best Hereford herd in America. He founded and for several years edited the American Hereford Herd Book.

29. Even though these several importations had been made, the Hereford did not gain a strong foothold in the United States until about 1880, when the western range country was opened. The Hereford proved its adaptability to that country and consequently a large expansion in the Hereford trade took place; this soon placed the breed second in point of numbers in the United States, the Shorthorn breed being first. Importations were made in 1880 by T. L. Beecher and C. M. Culbertson, of Illinois, and H. C. Burleigh, of Maine. M. H. Cochrane, of Hillhurst, Canada, also made extensive importations in 1880 and the succeeding years, and founded a noted herd. A number of choice Herefords were imported in 1881 by Adams Earl, of Lafayette, Indiana, who was one of the most successful Hereford breeders in America. Importations were made in 1882 by Gudgell & Simpson, of Independence, Missouri, and Earl & Stewart, of Lafayette, Indiana. The three most prominent and widely distributed strains, or families, of Herefords in the United States are descended from the imported bulls Anxiety, 2,238 (5,188), The Grove 3d 2,490 (5,051), and Lord Wilton (4,740).

30. Description.—In general conformation, the Hereford represents the beef type to an extreme, having a broad, deep, compactly built, thick-fleshed body set on short legs. The head indicates good feeding qualities, being short, wide, and sometimes slightly dished in the face, with a capacious mouth and wide nostrils. The horns are white or waxy yellow, often coarser and considerably longer than those of the Shorthorn; in cows and steers they are often a little elevated, but in bulls they are usually drooping. The neck is unusually short and blends well with the shoulders, which are smooth and well covered. The neck frequently carries a rather heavy dewlap and brisket, which is a point to be discouraged. The chest

is wide and deep, and the heart girth is good, indicating a good constitution. The short neck, capacious chest, well-covered shoulders, and full shoulder vein give the Hereford an unusually good front, one of the most striking features of animals of the breed. The back is broad and straight, with a wide thick loin. The ribs are well sprung and deep, the back and ribs carrying a large amount of flesh. The weak point of the Hereford is the hindquarters, as the rump is inclined to be sloping and the thighs lacking in thickness and depth. These defects, however, are being corrected by the best breeders. The skin is rather thin and covered with a long, thick, mossy coat. The breed is a little inclined to coarseness in the bone.

31. In Fig. 10 is shown a Hereford cow and in Fig. 11 a Hereford bull, both being typical animals of the breed. The color of the Hereford is red with white markings. The most common markings are a white face, a white stripe on top of the neck and sometimes part of the way down the back, white on the legs from the hock down, and more or less white on the belly. White may occur to a greater or less extent on any part of the body. The face is universally white, although occasionally a calf is dropped with spots on the face, showing a tendency to revert back to the old mottled-face character. The ears are usually red or spotted, and red spots around the eyes are common. The red may vary from light to dark, but a rich medium red is most desired. In size the Hereford ranks a little below the Shorthorn, but cannot be criticized for lack of size and scale. The bulls often weigh as much as 2,200 pounds and the cows 1,500 pounds or more.

32. Herefords, like the Shorthorns, are capable of adapting themselves to various conditions of life. Being heavy and large of frame, they are best adapted to level land and to conditions where they have an abundant supply of feed. They are deficient in milking qualities and are not suitable for conditions where a dual-purpose breed is desired, but in the production of beef they are unexcelled. Herefords have proved to be especially well adapted to range conditions and are used more extensively for the improvement of the cattle on the

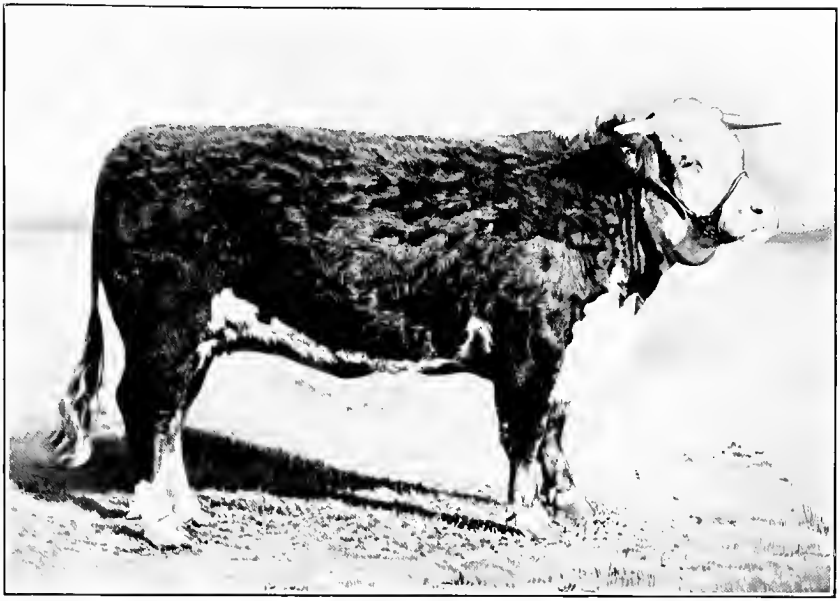


Fig. 10

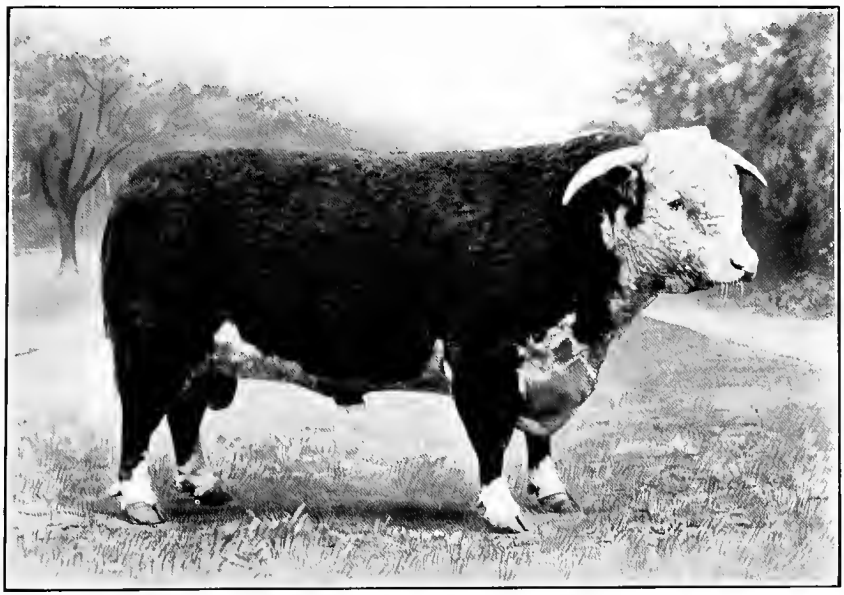


Fig. 11

ranges of the West and Southwest than are the animals of any other breed. They are exceptionally robust and hardy in constitution, are good feeders, and take on flesh rapidly.

The Hereford is unexcelled as a grazer and makes a good carcass on grass alone; on this account the breed is well suited to Western and Southwestern ranges. When fed, however, the Hereford is a good feeder and makes a prime carcass of beef. The quality of the meat is above criticism; it is tender, juicy, and of a good flavor, and the fat and lean are well marbled. The carcass carries a large amount of meat on the valuable parts and dresses out with a small percentage of offal. The Hereford matures early, the calves being used extensively for the production of prime baby beef.

The Herefords are good breeders, breeding regularly to an advanced age. They cross well with the Shorthorn, but not so well with other beef breeds, and are valuable for grading up common beef herds.

33. Polled Herefords.—For the last quarter of a century or more there has been an increasing demand in the United States for hornless, or polled, cattle. The excellent beef qualities of the Hereford being fully recognized, a few of the breeders have been attempting for a number of years to develop a hornless strain of the breed that will retain all the good qualities of the Herefords, but be without horns. At the present time it appears that these breeders will be successful. A polled Hereford cow is shown in Fig. 12 and a polled Hereford bull in Fig. 13. The cow is too high set and is rather long in the neck and face for a typical beef animal; the bull is of much better conformation.

34. Registration.—In England the registration of Hereford cattle is in charge of the Hereford Cattle Breeders' Association, which publishes the Hereford Herd Book. T. L. Miller, of Illinois, published in 1881 the first American Hereford Herd Book. The same year the American Hereford Breeders' Association was organized; this association now has charge of the Hereford registration in this country.

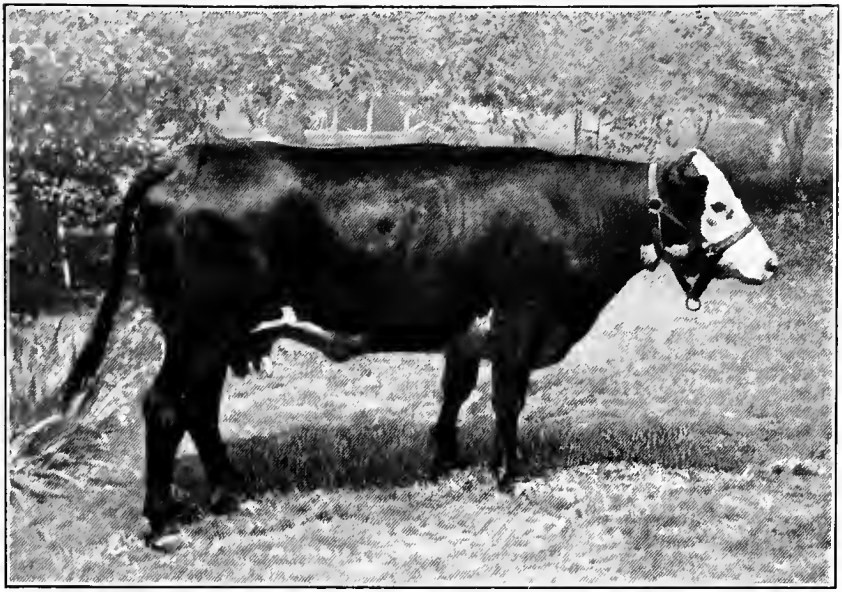


FIG. 12

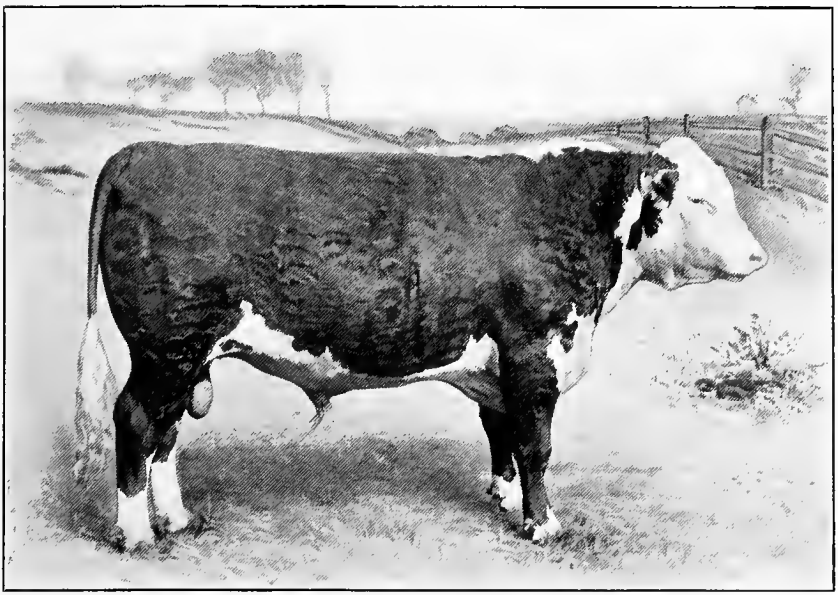


FIG. 13

ABERDEEN-ANGUS CATTLE

35. Origin and Development.—The **Aberdeen-Angus breed** of cattle is indigenous to the counties of Aberdeen and Forfar in Scotland. Forfar County was formerly called Angus. At an early period of the history of the breed there arose a controversy as to the name. The Aberdeenians wanted to call the cattle Aberdeens, and residents of Angus wanted to call them Angus. Finally, as a compromise, the name Aberdeen-Angus was adopted.

The origin of the breed is purely a matter of speculation. Among the wild cattle of Britain were polled animals, and it is possible the Aberdeen-Angus may have descended from these. A belief is held by certain Scotch writers that the breed is a sport from a horned black breed that formerly existed in Scotland. Hornless cattle have existed in Aberdeen and Angus for many years, being known by the Scotch farmers as "dodies" and "humlies." The improved Aberdeen-Angus cattle have descended directly from these native polled animals.

36. Noted early improvers of the Aberdeen-Angus were Hugh Watson, William McCombie, William Fullerton, and Sir George Macpherson Grant. Hugh Watson, of Forfar, was the first great improver of the breed. His ambition was aroused by a visit to the English Shorthorn country at about 1815. He began his work with a small herd of selected black cows and a black bull named Tarnty Jock. The work of Watson did much to make the Aberdeen-Angus cattle earlier maturing, heavier fleshed, and blockier than they had been before. William McCombie established his herd in 1830. He was a strong believer in the importance of individual merit coupled with good pedigree, and emphasized the value of the sire. McCombie founded the Pride and the Queen families, two of the most famous tribes of the breed. In 1878, he exhibited his herd at the Paris International Exposition, winning the grand championship against all breeds and attracting international attention. McCombie is considered by many to be the most distinguished improver and promoter of the breed.

William Fullerton established a herd in 1834 and added much to the prestige of the breed through the use of the bull Panmure (51).

Sir George Macpherson Grant is considered the most important of modern Aberdeen-Angus breeders, his herd having been considered since 1880 as the premier herd of Scotland. A number of the best bulls of the breed produced in the last quarter of a century were bred by Grant. Some of the most famous of his bulls are Juryman (421), Bushranger (732), Ermine Bearer 1,749, King of Trumps 2,690, Justice 854, Judge 473, Prince Ito (50,006), Bion 36,986, Emulus 20,417, Eblito 50,098, and Equestrian 34,216. The cows Erica 184 and Coquette 2,538 are among the most famous of the Grant cows.

The Aberdeen-Angus families in special favor at the present time are: the Queen, the Erica, the Pride, the Blackbird, the Heather Bloom, the Nosegay, and the Coquette. There are many other families of merit, of course, but these are the most popular.

37. Introduction Into America.—The first importation of Aberdeen-Angus cattle into America was made in 1873 by George Grant, of Victoria, Kansas, the shipment consisting of three bulls. These bulls were used on the horned cattle of the Indian Territory and Northern Texas, getting a large percentage of calves that were black and hornless. Two of the bulls were exhibited at the Kansas City fair the same year of their importation, where they excited admiration and curiosity. The first Aberdeen-Angus cow to come to America was, with two bulls, imported into Canada in 1876 by Professor William Brown, of the Ontario Agricultural College.

In 1878, Anderson & Findlay, of Lake Forest, Illinois, made an importation of five cows and one bull. This firm was the first prominent exhibitor of the Aberdeen-Angus cattle in the central west. Anderson & Findlay built up a valuable herd and have been successful exhibitors at leading state fairs. Importations were made in 1879 by F. B. Redfield, of Batavia, New York, and in 1880 by George Whitfield, of Rougemont,

Quebec. Mr. Whitfield imported the famous bull Judge (1,150), which was afterwards sold to Messrs. J. S. and W. R. Goodwin.

38. In 1881, Gudgell & Simpson, of Independence, Missouri, imported over thirty head, one of the largest lots ever brought to America. This firm exhibited a herd in 1882 which was awarded grand sweepstakes over all breeds at the Kansas City fair. The herd of Gudgell & Simpson was the medium through which many Aberdeen-Angus were distributed throughout the western part of the United States. Other importations made in 1882 were those of Henry & Matthews, of Kansas, and Geary Brothers, of London, Ontario. The latter exhibited the first Aberdeen-Angus steer seen at an American fat-stock show, the famous Black Prince, imported from Scotland in 1883. Geary Brothers probably imported more high-class animals than any other importers, and held several public sales of Aberdeen-Angus. Besides those mentioned, others who imported Aberdeen-Angus and founded herds in 1881 and 1882 were I. N. Hine, of Milan, Ohio; Mossom Boyd, of Bobcaygeon, Ontario; J. H. Pope, of Ontario; and M. H. Cochrane, of Hillhurst, Canada.

One of the most famous of early American Aberdeen-Angus herds was that of F. W. Harvey, of Chicago, which was established on his farm at Turlington, Nebraska. In charge of this herd was placed William Watson, a son of Hugh Watson, the famous Scotch breeder. Mr. Harvey imported two bulls and several heifers in 1882, and from these and other purchases he built up his herd. The Turlington herd made its appearance in the show yard in 1883, but was defeated by the herd of Gudgell & Simpson, but in 1884 its success began. That year it won grand sweepstakes over all breeds at the Nebraska state fair, and from that time until its dispersion in 1890 the Turlington herd was a leading winner at western shows.

The great breeding centers for Aberdeen-Angus cattle are the following states, given in the order of their importance: Iowa, Illinois, Missouri, Indiana, Ohio, Kansas, Nebraska, South Dakota, Minnesota, Wisconsin, Kentucky, Michigan, Texas, North Dakota, West Virginia, and Virginia. The

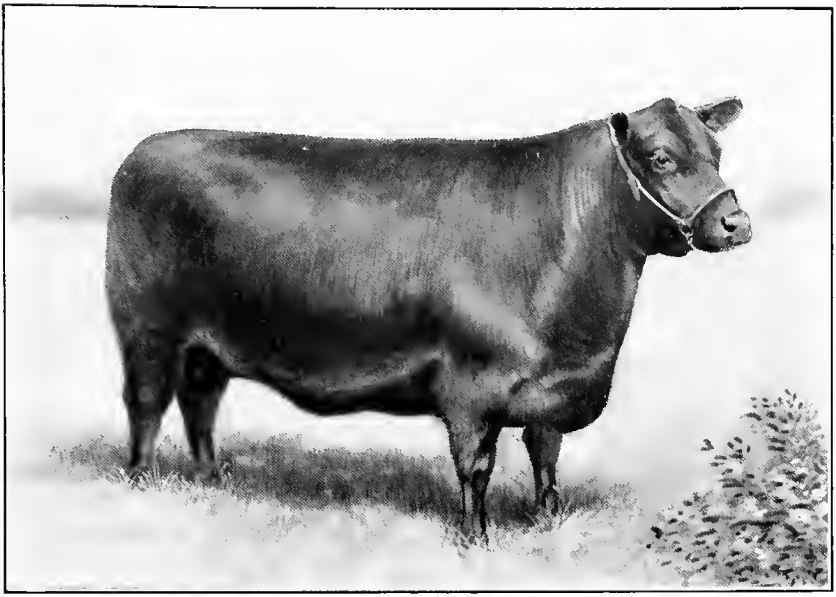


FIG. 14

FIG. 15

breed is gaining rapidly in these states, principally on account of its excellent beef quality and the hornless character.

39. Description.—Aberdeen-Angus cattle are said to be best adapted to temperate climates, provided shelter can be given to them in winter. Although reared in considerable numbers on the open ranges of the West, they are probably better adapted to what may be termed semi-range conditions, having the highest adaptation for arable land, level or undulating, where it is desired to produce meat of a high class. The absence of horns in the Aberdeen-Angus is favorable to feeding the animals loose in sheds and yards, and also to transporting them long distances by rail. In hardiness they are about medium. A typical Aberdeen-Angus cow is shown in Fig. 14 and a bull of the same breed in Fig. 15.

40. The striking features of the general outline of the Aberdeen-Angus are smoothness, compactness, and the cylindrical shape of the body. From the first, Aberdeen-Angus breeders sought to produce a barrel-shaped body, on account of the capacity of such a body for carrying a large percentage of net to gross weight, and the breed now possesses this character in the extreme. The Aberdeen-Angus are low-set; have great style, quality, and symmetry; and are evenly and smoothly covered with a wealth of firm flesh that retains its smoothness and firmness even if the animals are forced in fattening. The head shows all the indications of good feeding qualities, being short, broad, and clean cut, with a capacious mouth and large nostrils; the head is surmounted by a smooth and well-defined poll that is without any signs of horns or scurs; the ears are of medium size, well carried, and covered with hair; and the eyes are large and mild, indicating a good disposition. The neck is of medium length, clean about the throat and dewlap, and neatly joined to the shoulders, which are frequently coarse and prominent; the chest is wide and deep, with legs set well outside the body; the ribs are well rounded and deep, and well covered with flesh; the hindquarters are joined closely to the ribs; the back is straight, and although fairly broad, it has not, on account of the rounded shape of the body, the great width

of loin displayed by the Shorthorn; and the hook bones are well covered with flesh. One criticism of the Aberdeen-Angus is that the rump is frequently narrow and the tail set on too high. The hindquarters are rounded in appearance, carry a large percentage of flesh, and are deep in the twist; the flanks are low and full, giving an unusually straight underline; and the legs are short, with fine bone. Aberdeen-Angus animals show good quality, having fine bone and hair, and a pliable, though rather thick, skin. A striking feature of the breed is the marked uniformity that exists between different individuals.

41. In the early history of the breed, browns, blacks, reds, and brindles were common, but now black is the prevailing color, although red calves are occasionally dropped, showing a tendency to revert back to the old colors. White is objectionable except on the underline behind the navel, and it is tolerated there only to a moderate extent. In size, the Aberdeen-Angus is somewhat smaller than the Shorthorn; mature cows usually weigh from about 1,200 to 1,600 pounds and mature bulls, from about 2,000 to 2,200 pounds.

An important point in favor of the Aberdeen-Angus is their hornless character. The present tendency is toward hornless cattle, which year after year are coming more into favor with buyers, especially those for the eastern and export trade; even local packers now discriminate somewhat against horned cattle. There are good reasons for this, both from the standpoint of the shipper and the feeder. Horned cattle take up more room in sheds and at feed troughs, hence they require a larger equipment than an equal number of hornless cattle. In almost every lot of feeding cattle there are always a few timid ones, and in the case of horned cattle these are driven away from the feed troughs and consequently make poor gains; in the case of hornless cattle this difficulty does not exist to such a marked degree. Polled cattle can be packed more closely into cars and are more easily loaded and unloaded than horned cattle; this is a great advantage, especially in the case of export cattle. Polled cattle are quieter during shipment and consequently shrink less than cattle with horns.

Horned cattle wound each other more or less during shipment, and this always detracts from their selling price. The wounds show up on the dressed carcass, spoiling its appearance, and every hole in the hide caused by a prod of a horn renders it less valuable for tanning purposes and causes it to sell for a lower price. For these reasons, polled cattle are of more value to the packer, consequently he is able to pay more for them. All other things being equal, a discrimination of from 10 to 15 cents per hundredweight is usually made in favor of horn-less cattle.

42. It is frequently claimed that the Aberdeen-Angus surpasses all other breeds in the production of beef. There is, of course, a considerable difference of opinion as to this, but it is safe to say that the Aberdeen-Angus is second to none as an all-round beef breed, and is, in some respects, superior to all others. This claim is substantiated by the position that the breed has taken at the leading fat-stock shows and by the high regard in which the meat is held in the market.

Aberdeen-Angus cattle are good grazers and feeders. They make good gains, and make as large returns for the feed consumed as the animals of any other breed. The quality of the flesh is generally considered as superior to that of the animals of any other breed. It generally contains a greater proportion of compact, finely grained flesh and less soft, coarse fat than the meat of most other animals, and the lean and fat are better mixed, giving the marbling that is necessary to high-class beef. Another point of superiority of the breed lies in the fact that the animals dress a large percentage of carcass to live weight.

43. Formerly, the Aberdeen-Angus were rather slow in maturing, but the breed has been improved in this respect so that the animals mature fully as early as those of any of the leading beef breeds. Good specimens, when properly fed from birth, may be ready for the butcher at from 24 to 30 months of age. They also fatten readily and may be fitted for the market at almost any age desired.

Formerly, the breeding qualities of the Aberdeen-Angus were of the highest order. Like the animals of all other breeds

that have been subjected to artificial conditions, however, their breeding qualities have been more or less impaired, but they may still be regarded as at least up to the average. The Aberdeen-Angus stands second to no other breed for grading up a common herd when it is desired to secure quick-feeding, early maturing cattle that will produce a high quality of meat. An Aberdeen-Angus bull used on such a herd will produce about 90 per cent. of hornless calves, and a large proportion of them will have the black color and uniform conformation and appearance of the Aberdeen-Angus, a point that has no inconsiderable bearing on the market value. The excellent feeding qualities and quality of flesh of the "blue-roan" steer, the result of a cross of the Aberdeen-Angus and the Shorthorn, is well recognized in America.

The milking qualities of the Aberdeen-Angus have been considerably neglected, more attention having been paid to beef production. However, there are some individuals and certain strains of the breed that make a creditable showing as milkers.

44. Registration.—The registration of Aberdeen-Angus cattle in Scotland is in charge of the Polled Cattle Society of Scotland, which publishes the Polled Cattle Herd Book. In America, the registration is in charge of the American Aberdeen-Angus Breeders' Association, which publishes the American Aberdeen-Angus Herd Book.

GALLOWAY CATTLE

45. Origin and Development.—The native home of the **Galloway breed** of cattle is in the southwestern part of Scotland. The breed derives its name from that of Galloway, a district now comprising the counties of Kircudbright and Wigton, but which in ancient times was much more extensive. The origin of the Galloway is obscure. According to Macdonald and Sinclair, noted authorities on polled cattle, there is scarcely any doubt that the Galloway cattle are direct but modified descendents of the horned race that formerly existed in the

old Galloway district. It seems probable that from this native foundation stock the farmers of the district, favoring polled cattle, gradually produced a hornless breed.

It is the opinion of most writers on the subject that within the history of the Galloway breed there has been no infusion of outside blood. A proof of the purity of breeding of the Galloways is the power with which they transmit their hornless character to offspring when crossed with horned animals. It has been assumed that in-and-in breeding has not been practiced by Galloway improvers, but that the development of the breed has largely been brought about by the selection of the best animals for breeding purposes. About 1840, dairying became popular in the Galloway district and as a result the Galloways suffered severely from neglect. Active interest in the breed was not reawakened until about 1877.

Among the early improvers of the Galloways were: the Earl of Selkirk, the Murrays of Broughton, the Herrons of Kirrouchtrie, the Gordons of Greenlaw, the Maxwells of Mouneith, the McDowals of Logan, the Cathcarts of Genoch, the Hawthorns of Castlewig, and the Stewarts of Phygell.

46. Introduction Into America.—The first recorded importation of Galloways into America was made in 1853 by James Graham, of Vaughn, Ontario, Canada. This importation consisted of ten animals, among them being Jet 2, Venus 3, Chloe 4, Bonny 1, Phillis 7, Blacky 8, Bell 9, and the yearling bull Jock 10.

From these animals have come many of the Galloway herds in America. The person that did more than any one else for the disseminating of early Galloway stock in America was Thomas McCrae, of Guelph, Ontario. He imported his first Galloways into Guelph in 1861, and made other importations at frequent intervals for several years. Volume VI of the American Galloway Herd Book states that there are few herds in America that do not contain animals tracing to those owned at one time by Mr. McCrae. Of the 1,839 pedigrees recorded in Volume IV of the American Galloway Herd Book, 761 trace to animals once owned by him. Another man who imported a

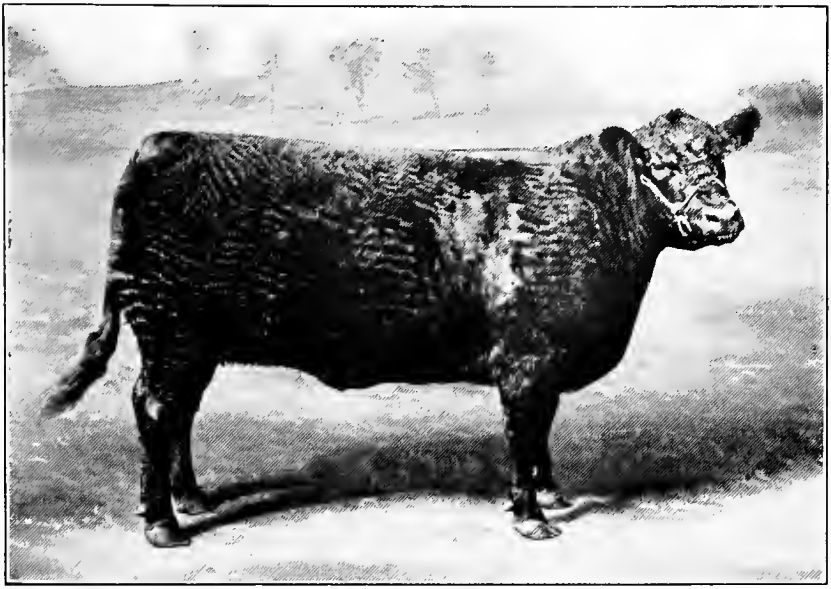


FIG. 16

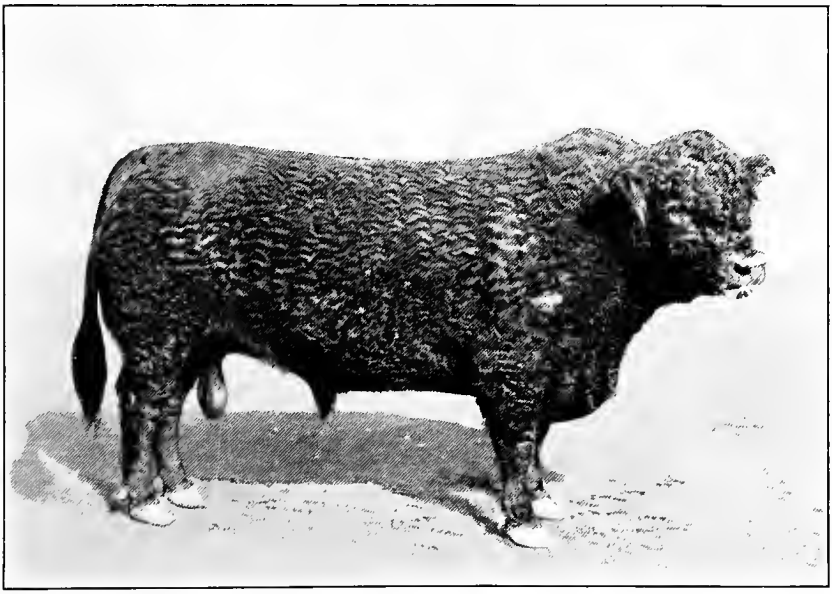


FIG. 17

large number of Galloways into Canada was Simon Beattie. The first direct importation of Galloways into the United States was made into Michigan in 1870.

Among the early cows imported to America, besides those already named in the Graham importation, may be mentioned Maggie 48, Blooming Heather 53, Newbie Lass 75, and Pollie Shaw 174. Some of the bulls imported were Young Lochinvar 303, Macleod of Drumlanrig 470 (1,564), Macleod 2d of Drumlanrig 553 (1,676), Arabi Bey 548, Elrig 551, and Sam of Garlieston.

The states in which the breed is most widely distributed, in the order of their importance, are: Kansas, Missouri, Nebraska, Iowa, and Illinois. Galloways are becoming very popular in the western states, especially on the fenced ranges, where they seem to be ideally adapted.

47. Description.—The Galloways are best adapted for a cold, damp climate, their special qualifications for these conditions being ruggedness and a thick coat of hair that protects them from cold and rain. They have been found very suitable for Dakota, Montana, and Idaho ranches, and for the Canadian Northwest. Being of a rather small frame and very muscular and active, they are well adapted to rugged pastures. C. C. Georgeson, of the Alaska Experiment Station, has recently taken a number of Galloways from the United States with the view of acclimatizing them to Alaskan conditions.

In Fig. 16 is shown a Galloway cow and in Fig. 17 a Galloway bull, both good representatives of the breed. The Galloway is a thick, low-set, symmetrical, black, polled animal, resembling somewhat the Aberdeen-Angus. In good animals the head is short and broad, without any trace of horns or scurs, and is surmounted by a poll that is not quite as sharp as that of the Aberdeen-Angus. The ears are set a little farther back than those of the Aberdeen-Angus and point forwards and upwards, and have a fringe of long hair. The body is cylindrical but somewhat longer and flatter in the rib than that of the Aberdeen-Angus. The Galloway is especially vigorous and robust in constitution, and is able to withstand a rigorous

climate. The body is covered with a long, thick, curly coat, especially in winter. The hides, when removed in winter and properly tanned, make good lap robes, overcoats, and fur caps.

48. The color of the Galloway is black with a brownish tinge; white markings on the feet, legs, or any portion of the body above the underline are very objectionable. At one time brindled animals were common, but since the fashion set in for blacks, other colors have become rare. The calves when first dropped are usually a dark mahogany brown.

In size, the Galloway hardly equals the Shorthorn, Hereford, or Aberdeen-Angus. Galloway steers can usually be made to weigh from 1,000 to 1,200 pounds as yearlings past; from 1,200 to 1,400 pounds at 2 years old; and from 1,400 to 1,600 pounds at 3 years old. Mature bulls will weigh about 1,800 to 1,900 pounds, and mature cows from about 1,200 to 1,500 pounds.

The meat of the Galloway has long been prized for its good quality. It is fine grained and well flavored, the fat and the lean being well marbled, with a large percentage of lean. Galloways fatten smoothly and uniformly, without any tendency to patchiness. They are good grazers and feeders, and when fed well they will mature rapidly and produce fine carcasses. The Galloway has been criticized as being slow maturing; it is being improved in this respect, but is not yet the equal of the Shorthorn, Hereford, or Aberdeen-Angus.

Like all other breeds of cattle that have been reared under natural and severe conditions, the Galloway is excellent in breeding qualities, but these become impaired by pampering or too rapid forcing.

A Galloway cross on an animal of almost any of the beef breeds will produce a good beef animal; the "blue-gray" steers that are so highly prized on the London markets are crosses of the Galloway and the Shorthorn. A Galloway bull is valuable in grading up a common beef herd, especially in localities to which the Galloway is peculiarly adapted. On account of having being bred pure for a great length of time, the Galloway is very prepotent. When a Galloway bull is used on a common herd, 90 per cent. of the calves will be black and hornless.

The Galloway is distinctly a beef breed and lays no claim to milking qualities, although the animals produce enough milk to raise their calves, and the milk is of good quality.

49. Registration.—Previous to 1878, the Galloways in Great Britain were registered with the Aberdeen-Angus in the Polled Herd Book, the first volume of which appeared in 1862. The Galloway Cattle Society was formed in 1877 and began a separate registration of Galloways. The first volume of the Galloway Herd Book as distinguished from that of the Aberdeen-Angus was published in 1878; since that date sixteen volumes have been published. The registration of Galloways in Canada was begun in 1872 by the Agricultural and Arts Association, and the first volume of the American Galloway Herd Book was published in 1883. The American Galloway Breeders' Association was founded in 1883. It purchased the interests of the Agricultural and Arts Association of Canada, and since its organization has registered the Galloways of North America and has published the American Galloway Herd Book.

SUSSEX CATTLE

50. Origin and Development.—The **Sussex breed** of cattle is native to Sussex County in the southern part of England, but the Sussex are bred also in the adjoining counties of Kent, Surrey, and Hampshire. The origin of the breed is more or less obscure; however, the early writers on British livestock agree that the Sussex have descended from the old medium-horned cattle of Great Britain, from which descended also the Devon and the Hereford breeds. This assertion is strongly supported by the greater or less resemblance between the Sussex, the Devon, and the Hereford.

In size, the Sussex have always been rather large. Formerly they were used for draft purposes, in tilling the soil, and for other kinds of work, being both agile and strong, and were usually not fattened and killed until they had served their purpose as work cattle, which was usually at about 6 or 8 years of age. It is only within the last 50 years that much of an

FIG. 18

FIG. 19

attempt has been made to improve the breed, but in that time it has been materially changed. Since the decline in the demand for oxen, the Sussex has been bred more for the production of beef; it has been refined in symmetry and improved in quality, early maturity, and the development of valuable parts.

51. Introduction Into America.—The first importation of Sussex cattle into the United States was made in 1884, by Overton Lea, of Nashville, Tennessee. In 1891, the Ontario Experiment Station at Guelph made a small importation into Canada. The present distribution of the Sussex in this country is rather limited. Besides the herd of Mr. Lea, in Tennessee, there are a few small herds in Canada, Illinois, Indiana, and in some of the trans-Mississippi states.

52. Description.—The Sussex are best adapted to localities that are rich in crop production and temperate in climate. Their grazing qualities are nearly if not quite equal to those of the Herefords. The Sussex are very hardy, which is due largely to the manner in which they have been handled, having long been accustomed to working and never having been pampered.

In Fig. 18 is illustrated a Sussex cow that was bred in England. The color of the Sussex is solid red, a moderately deep shade being preferred. The horns are inclined to be large and long, curving around in front and often inclining slightly downwards. The nose is of flesh color. The form is blocky, the ribs being well sprung and long, and the body capacious. The Sussex is comparatively large, ranking about on a par with the Hereford in size. The average weight of mature cows is about 1,400 pounds and of mature bulls about 2,000 pounds.

The Sussex has long been held in high esteem as a beef breed, as might be assumed from the excellent showing it has made at fat-stock shows in England. In beef production it is comparable to the Shorthorn and the Hereford. The animals of the breed produce meat that is of good quality and very acceptable in the British markets. The breeding qualities of

the Sussex are excellent, and it makes a good cross with any other breed, imparting substance and firmness of flesh, and generally transmitting the red color.

53. Registration.—The English Sussex Herd Book was begun in 1860 as a private enterprise by Alfred Heasman, a prominent Sussex breeder. The herd book has since been acquired and is now published by the Sussex Herd Book Society. In America, the interests of the breed are looked after by the American Sussex Cattle Association, which publishes the herd book.

DUAL-PURPOSE BREEDS

DEVON CATTLE

54. Origin and Development.—The **Devon breed** of cattle originated in Devonshire and the adjoining counties in the southwestern part of England. Little is known of the origin of the breed, but it is known to be one of the oldest of the British breeds of livestock, and is supposed to have been gradually developed from the aboriginal cattle of Great Britain, from which descended also the Hereford and the Sussex. The cattle of North Devon have been developed particularly for beef production, and those of South Devon for milk production. The two types have been more or less intermingled, but the best Devon breeders of today favor adherence to the dual-purpose type.

55. Introduction Into America.—Devons were among the first cattle to be brought across the Atlantic. It is reported that a number were brought to New England in 1623. Other importations were made into Massachusetts in 1800, and to New York in 1805. The first herd of registered Devons in the United States consisted of six heifers and the bull Taurus (320), presented to Robert Patterson, of Baltimore, Maryland, by the Earl of Leicester. The Patterson herd was kept pure for many years, and most of the early Devon herds in America descended from it. During the first half of the 18th century,

several importations were made, and the breed became widely distributed over the country.

56. Description.—The Devon is graceful and symmetrical in outline, round in form, and fine boned. The body is blocky, with a straight, broad, level back, and set on short, fine legs. The head is small, tapering considerably toward the nostrils; the nose is of a creamy white; the jaw is clean and free from flesh; the eye is bright, lively, and prominent, and is encircled by a deep orange-colored ring; and the ears are thin. The horns of the female are long, spreading, and gracefully upturned; the horns of the male are thick and less curved than those of the female, in some instances standing out nearly square, with only a slight inclination upwards.

In Fig. 19 is shown a typical bull of the Devon breed. In color, the Devon is a solid red, with the exception of deep orange-colored rings around the eyes and occasionally a small amount of white in front of the udder or the scrotum and in the switch. White is not permissible on any other part of the body. The red varies from dark to light; some breeders prefer one shade and some the other.

The Devon is smaller than the Shorthorn and the Hereford, the size varying greatly, however, with the breeding, feeding, and care. The lack of size of the Devons makes them less popular than they would otherwise be, but what they lack in size they make up in quality, fattening powers, compactness of flesh, perfection of form, splendid handling qualities, and beauty when finished. The average weight of mature cows is about 900 pounds and of mature bulls about 1,200 pounds. The bulls seldom weigh more than 2,000 pounds.

57. The grazing qualities of the Devons are high class, and this, together with their small, active bodies, adapt them to scant pastures. They do particularly well in some of the hilly sections of the New England and other of the eastern states. Combining fair flesh and milk-producing qualities, the Devons are very suitable animals for hilly regions where a system of mixed farming is followed. The breed is only fair in early maturing qualities, but the animals will mature fairly

early if well kept. The breeding qualities are at least fair, due to the natural conditions under which the Devons have been kept. Owing to the long period during which they have been bred pure, they are prepotent.

As a rule, Devon cows do not yield large quantities of milk and are not persistent milkers; yet some families, bred and selected for dairy purposes, have made fair milk records, single animals producing 40 and even 50 pounds of milk per day. The milk of the Devon is rich in quality, ranking next to that of the Channel-Island cattle in percentage of butter fat, total solids, and high color, being in these respects well above the average milk of the dairy cows of the country.

Although it is believed that the Devon is not commonly held in as high esteem in the United States, either as a dairy breed or a general-purpose breed, as is really justified by its merits, the best friends of the breed regard it as more particularly a beef producer. The calves are usually fat and lusty, showing a vigorous growth, and the cows and steers are easily kept in good order and fatten readily. At the prominent fat-stock shows of England the Devons have year after year won high honors for butchers' meat. The beef is fine grained, usually tender, and well marbled, and the fat is of a deep yellow color.

The Devons have long been prized as beasts of burden. In New England and the other eastern states, when oxen were extensively used, the Devon was a great favorite, Devon oxen being intelligent and exceedingly active.

58. Registration.—The registration of Devons in England is conducted by the Devon Cattle Breeders' Society and the South Devon Herd Book Society. In America, the organization for the promotion of the breed is known as the American Devon Cattle Club, which publishes the American Devon Record.

RED POLLED CATTLE

59. Origin and Development.—The **Red Polled breed** of cattle is native to the counties of Norfolk and Suffolk, in the eastern part of England. It is the result of the crossing of the old Norfolk and Suffolk breeds. The breed is one of the youngest, although the Norfolks and Suffolks have existed in England from time immemorial. The amalgamation of the two breeds took place about 1846. There was a friendly rivalry between the Norfolk and the Suffolk breeders at the agricultural shows and an interchange of the best blood was constantly kept up, so that it is doubtful if there are any Red Polled herds that do not contain blood of both strains. At first individuals varied greatly, according to whether the Norfolk or Suffolk characters predominated, but in time they became more uniform. The resulting breed retained the large size of the Suffolk and the dark-red color and fine quality of the Norfolk. The modern Red Poll does not give as large a quantity of milk as did the old Suffolk breed, but the milk is of better quality.

In Great Britain the breed is not very widely known outside of the counties of Norfolk and Suffolk. This is due mainly to the fact that a few years ago rinderpest, or cattle plague, destroyed large numbers of the cattle and there has since been a scarcity of stock; it is also due somewhat to the popularity of the Shorthorns and the Devons. Within the last 15 or 20 years, however, the Red Polls have been increasing in popularity.

60. Introduction Into America.—The first importation of modern Red Polls into America for breeding purposes was made by G. F. Taber, of New York, in 1873. This importation consisted of a bull and three heifers. In 1875, Mr. Taber imported four cows, and in 1882, three bulls and twenty-three heifers. In 1882, Mead & Kimball, of Vermont, imported a bull and ten females G. P. Squires, of New York, and Geldard & Busk, an English firm, made importations in 1883. From this time on the number brought over kept increasing from

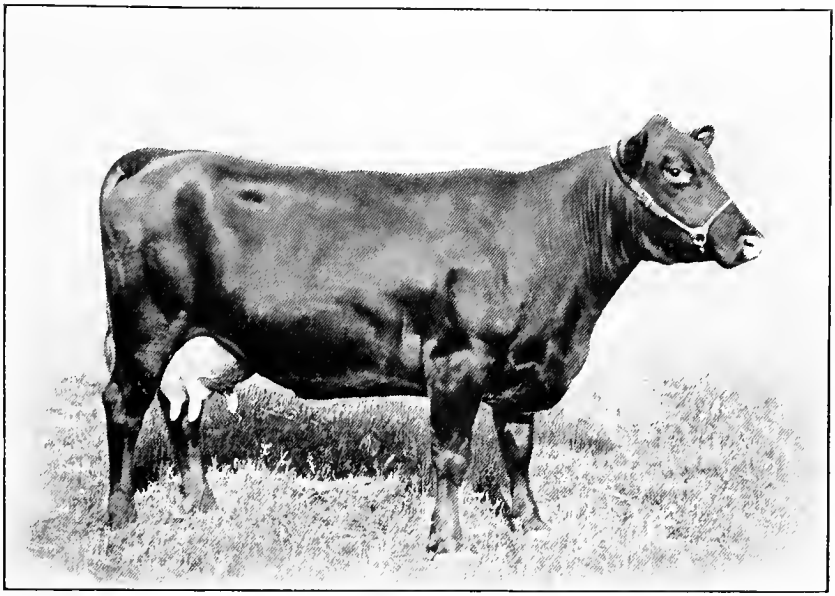


FIG. 20

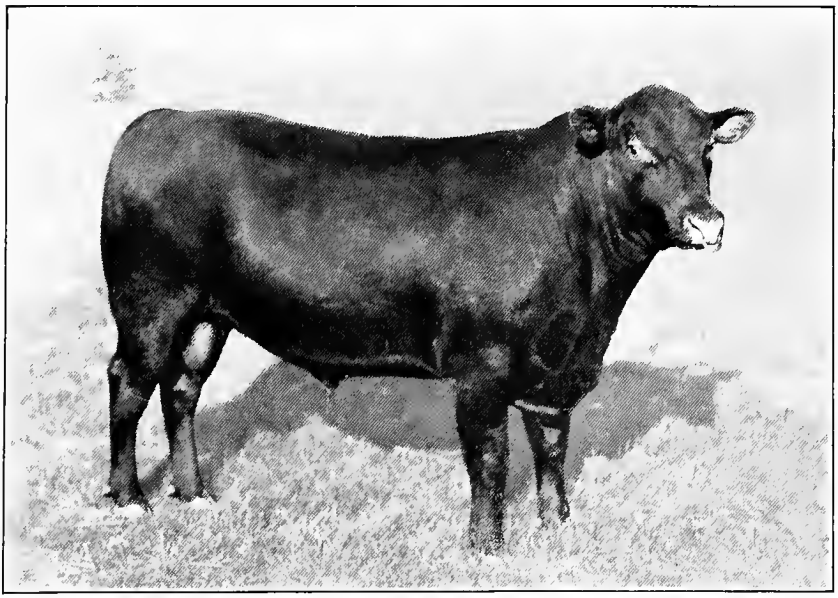


FIG. 21

year to year until the prices in Great Britain became so high as to make the business unprofitable.

Red Polls are the most popular and widely distributed in Wisconsin, Iowa, Illinois, Ohio, Texas, Nebraska, and Michigan, in about the order named. The breed is steadily gaining in popularity in states where general farming is practiced.

61. Description.—The Red Polled breed is one of the best of the dual-purpose breeds. Red Polls produce an abundant quantity of milk and the steers fatten readily, producing carcasses that are very acceptable to the butcher. As the name implies, the animals are without horns, all indications of such being very objectionable. The head is characteristic, being medium in size and clean cut, with a sharp poll that carries a tuft of hair. The neck is of medium length; the body is of good size and shape; and the legs are medium in length. It is claimed that the Red Poll bears the same resemblance to the Devon that the Polled Durham bears to the Shorthorn. Red Polls are of much the same size, color, and form as the Devons, about the only difference being that the former are without horns. The Red Polls have been developed more as a dairy breed than the Devons. The principal weaknesses of the breed are the unevenness of size, shape, and setting of the teats, and a lack of uniformity throughout. In many cases the teats are unduly large, puffy, and conical. The lack of uniformity is due to different aims of the breeders, some breeding for beef production and others for milking qualities.

62. In Fig. 20 is shown a Red Polled cow and in Fig. 21 a Red Polled bull. These animals are fairly typical of the breed. The color of the Red Poll is red, varying from a light to a dark shade. A solid red is preferred, but a little white is permissible on the udder, on the belly, and on the switch of the tail. In size, the Red Poll ranks below the animals of any of the beef breeds. Typical mature bulls of the breed will weigh from about 1,800 to 2,000 pounds, and mature cows from about 1,100 to 1,300 pounds.

Although the dairy qualities of the Red Poll do not rank with those of the special dairy cattle, the breed stands high

in this respect among the dual-purpose cattle. No very complete records are available in this country, but in England records have been kept and are published in the English Herd Book. The two best milking herds in England are those of Garrett Taylor, of Whitlingham, near Norwich, and of Lord Rothschild, at Tring Park, both of which are maintained for the production of milk for the London city trade. It is said that good herds in England average 5,000 to 5,500 pounds of milk per cow per year, and small selected herds will produce as much as 7,000 pounds. One Red Polled cow has a record of producing 14,189 pounds of milk in 1 year. At the Pan-American Exposition, five Red Polled cows in a 6 months' public test made the following record:

Name	Milk Pounds	Butter Pounds
Mayflower 2d	6,161	323
Susie	6,430	287
Easter	6,058	264
Tryste	5,422	235
Flora 2d	4,628	233

Of the fifty cows tested for profit in butter production, including Guernseys, Jerseys, Ayrshires, and Holstein-Friesians, the Red Polled cow Mayflower 2d took second place.

Red Polled cattle rank well as beef producers. They usually do not win the highest honors in open competition in the beef show ring, but they are profitable feeders and make a good grade of beef.

63. Registration.—In 1874, the first volume of the English Red Polled Herd Book was edited and issued as a private venture by Henry F. Euren. This publication has since been transferred to the Red Polled Society of England, which has continued its publication. The interests of the breed in the United States are promoted by the Red Polled Cattle Club of America. This organization publishes the Red Polled Herd

Book. When the American herd book was first issued and up to 1901 it contained the English registrations as well as the American, but since 1901 only American-owned animals are registered in the American publication.

BROWN SWISS CATTLE

64. Origin and Development.—The native home of the **Brown Swiss breed** of cattle is the Canton of Schwyz, in the eastern part of Switzerland, where the Brown Swiss are the common cattle found in the mountain pastures. The origin of the breed is probably prehistoric. It is generally conceded that it is very old, and that it has been bred with much purity and care by the Swiss farmers. The Brown Swiss cattle comprise about two-fifths of the cattle of Switzerland, the other three-fifths being of the Simmenthal breed, which is closely related to the Brown Swiss. Only a few of the Simmenthal cattle have been imported into America.

65. Introduction Into America.—The first importation of Brown Swiss cattle into America was made in 1869 by H. M. Clark, of Belmont, Massachusetts. This importation consisted of a bull and seven heifers. In 1882, Scott & Harris, of Massachusetts, imported nine heifers and a bull, and in 1883 ten heifers. Among the most prominent importations of recent years was that of McLaury Brothers, of New York, in 1904. The cattle of this importation were show animals, and were exhibited at the Louisiana Purchase Exposition at St. Louis and at various state fairs. The breed has never become very popular in the United States, although it has a number of excellent qualities.

66. Description.—The Brown Swiss are of large size and rather heavy form. The bones are large and strong, giving the animals a sturdy appearance. In form, the Brown Swiss are distinctly blocky, being much more so, in fact, than the animals of any other dual-purpose breed. They are of a uniform dark grayish-brown or mouse color, shading to gray in the flanks and on the belly, and with a light ring about the muzzle.

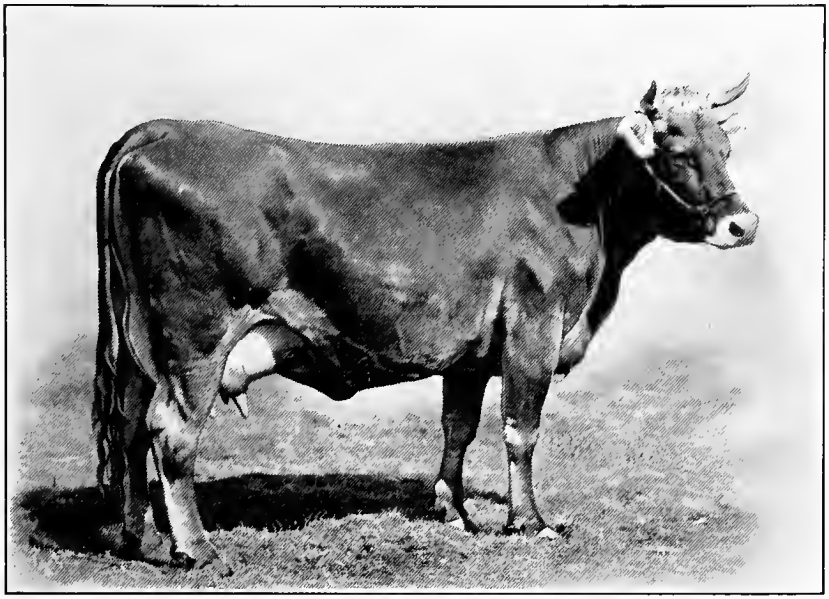


FIG. 22

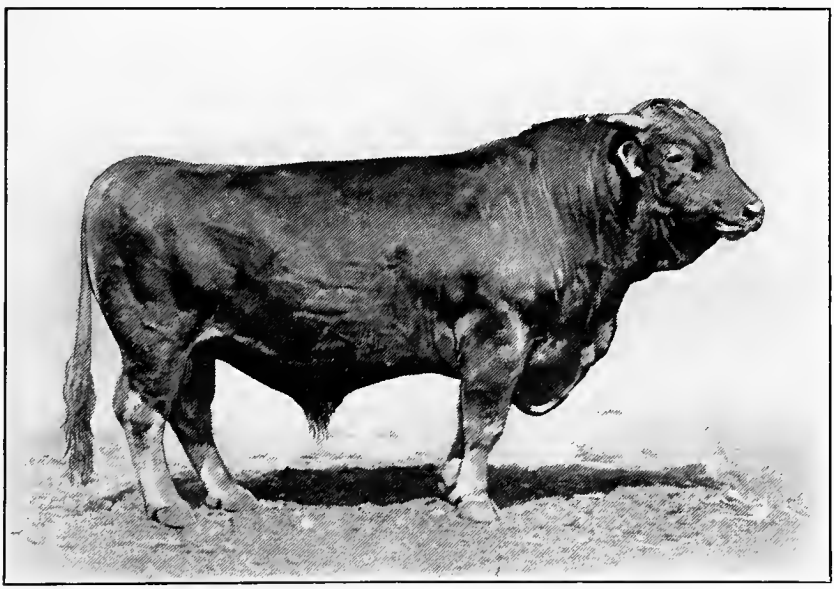


FIG. 23

212—32

Occasionally, an animal will shade a little darker toward black and sometimes one will shade a trifle lighter toward gray, but as a general thing there is little variation in the color. A mature cow of the breed will usually weigh from about 1,300 to 1,400 pounds, and a mature bull from about 1,500 to 1,800 pounds; the size is somewhat variable, however, being smaller in the mountainous districts than in the lower regions. A typical Brown Swiss cow is shown in Fig. 22 and a bull in Fig. 23.

The Brown Swiss are adapted to a wide range of conditions. In their native home they thrive on rations that would not be regarded as satisfactory in America, consequently they are remarkably hardy. Their special place in this country would seem to be in the more elevated regions where a rugged breed is desirable. In milk production they can scarcely compete at the present time with the special dairy cattle. They rank well in Switzerland as beef producers, but have never become popular in American beef-cattle markets.

67. Registration.—The registration of Brown Swiss cattle in America is in charge of the American Brown Swiss Breeders' Association, which publishes the herd book.

SHORTHORN CATTLE

68. The **Shorthorn breed** of cattle has already been discussed as a beef breed, but certain strains of the Shorthorns have so long occupied an important place as dual-purpose cattle that a discussion of the dual-purpose breeds would not be complete without some mention of this great breed. In some parts of England and in some strains of blood the dairy qualities have been maintained to a considerable degree. This is particularly true of strains that trace to the Bates line of breeding. The Shorthorns that were introduced into the eastern part of the United States were largely of the milking type, and a few herds have been maintained that are satisfactory milk producers. Within recent years an effort has been made to develop the dairy qualities of the breed, which

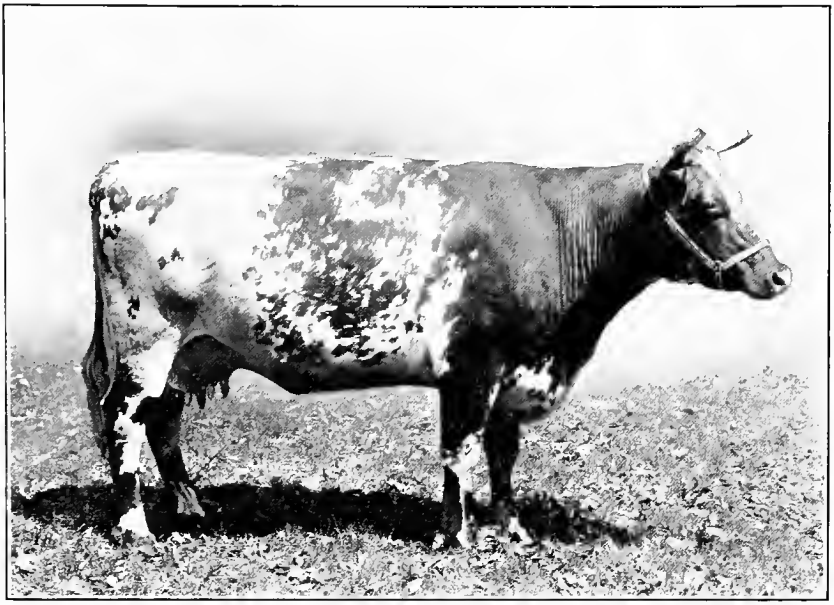


FIG. 24

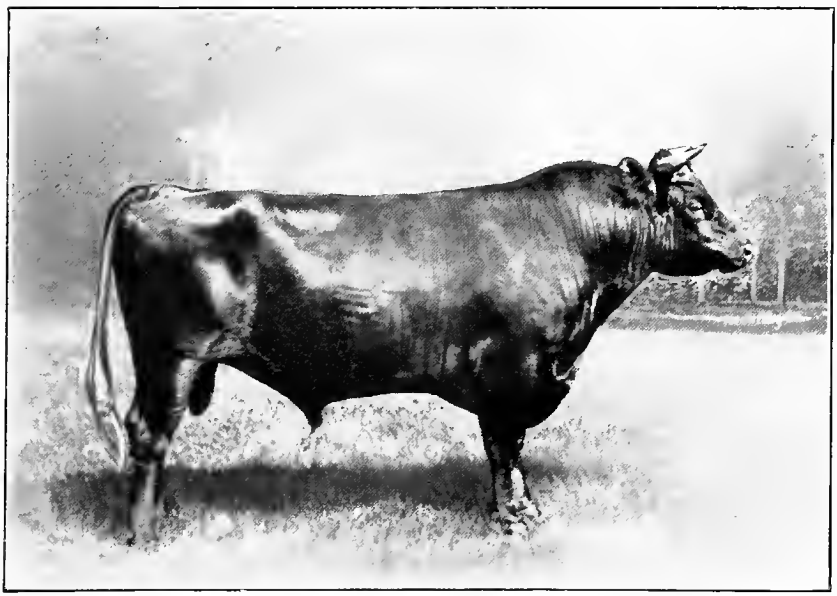


FIG. 25

as a whole have received little attention and have almost entirely disappeared. Grade Shorthorns have proved to be valuable as dual-purpose cattle, and are to be found on a large number of farms in the United States. A typical cow of the milking strain of Shorthorn is shown in Fig. 24, and a bull of the milking strain in Fig. 25.

BEEF AND DUAL-PURPOSE CATTLE

(PART 2)

MARKET CLASSES OF CATTLE

INTRODUCTORY REMARKS

1. Variations in the quality, condition, weight, and age of cattle reaching the great livestock markets make it necessary that different classes and grades be established. If it were not for these classes and grades it would be impossible properly to designate different kinds of cattle and intelligently to report market conditions through the public press. Although the limits and characteristics of the different classes and grades are somewhat variable, owing to fluctuations in the supply of and the demand for cattle, they are sufficiently distinct to allow of definition and description.

The value of a thorough knowledge of the various market classes and grades of cattle should be fully appreciated by breeders and feeders of beef cattle. Without a knowledge of feed-lot and market requirements, the breeder or the feeder is at a decided disadvantage. If he obtains a profit from his cattle it is more the result of chance than of a definitely determined and intelligently executed plan. Guess work in cattle breeding or feeding is more often followed by loss than by profit.

Those familiar with the cattle business know that there often exists a wide difference between the selling price of

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY ALL RIGHTS RESERVED

cattle on the market and the previous estimate of the feeder as to what they should bring. The feeder that feeds but a few cattle and seldom accompanies his shipments to market has little opportunity to learn market conditions and requirements; on the other hand, the feeder that feeds on an extensive scale and frequently visits the cattle markets has an excellent opportunity to acquire information. Feeders must rely largely on market reports, however, for information regarding the condition of the cattle trade. Market reports are, of course, more intelligible to persons that are thoroughly familiar with stockyard terms than to those that seldom visit the markets; for this reason, cattlemen should visit the great cattle markets as frequently as possible. Inability on the part of the feeder correctly to interpret market quotations places him at a disadvantage either in selling his cattle to a shipper or in shipping them to the open market.

It might appear on first thought that a knowledge of market requirements and conditions would be of little interest and importance to a breeder of pedigreed beef cattle. Unless a breeder possesses such information, however, he is likely to attach too little importance to the fact that the only reason for the existence of the improved breeds of beef cattle is that they facilitate the economical production of beef of high quality. The first point for the breeder of pedigreed beef cattle to familiarize himself with is the demands of the fat-cattle market.

It is practically impossible to give a definite market classification of cattle that will be applicable under all conditions. All classes and grades that may be established must necessarily be somewhat variable, because of variations in the quality, condition, and visible supply of cattle and the activity of the market. For instance, a lot of cattle that one day would be classed as stockers and feeders might, under different market conditions, be classed as beef cattle. It should be understood, then, that a market classification of cattle cannot be definite and unvariable in its practical application.

It is the purpose in the following pages to give a market classification of cattle that will make clear, so far as is possible, the actual workings of the cattle market, and at the same

MARKET CLASSES AND GRADES OF CATTLE

CLASSES	GRADES
Beef cattle	Prime steers
	Choice steers
	Good steers
	Medium steers
	Common rough steers
Butcher stock	Prime heifers
	Choice heifers
	Good heifers
	Medium heifers
	Prime cows
	Choice cows
	Good cows
	Medium cows
	Common rough steers
	Choice bulls
	Good bulls
	Medium bulls
Cutters and canners	Good cutters
	Medium cutters
	Common cutters and good canners
	Medium canners
	Inferior canners
	Bologna bulls
Stockers and feeders	Fancy selected feeders
	Choice feeders
	Good feeders
	Medium feeders
	Common feeders
	Inferior feeders
	Feeder bulls
	Fancy selected yearling stockers
	Choice yearling stockers
	Good yearling stockers
	Medium yearling stockers
	Common yearling stockers
	Inferior yearling stockers
	Good stock heifers
	Medium stock heifers
	Common stock heifers
Veal calves	Choice
	Good
	Medium
	Common
Milkers and springers	

time to emphasize the necessity of cattlemen keeping in close touch with the market. In order to become proficient in buying and selling cattle, a cattleman must be thoroughly acquainted with the ideal type for each class and grade, and in addition must know exactly what the market demands.

2. The accompanying tabulation showing the different market classes and grades is a classification of cattle made by Prof. Herbert W. Mumford, of the University of Illinois, one of the foremost authorities on beef cattle. This classification is essentially the same as that used at the different livestock markets and by the public press, with the exception that all meaningless terms are omitted. The names of the various classes indicate the uses to which cattle in them are put. The names of the grades refer to the quality, condition, conformation, and weight of the cattle in each class.

BEEF CATTLE

3. In the **beef-cattle class** are included all grades of fat steers and occasionally the best grades of fat heifers and cows. Condition and quality rather than weight determine whether an animal shall be included in this class. For instance, an 800-pound yearling of quality and finish would more consistently fall into the beef-cattle class than a heavier, plainer steer lacking either quality or condition, or both. Beef cattle are in demand in the Chicago market by three classes of buyers: exporters, packers, and shippers. Exporters desire fat cattle for export to the British markets; packers desire them for slaughter in Chicago as dressed beef; and shippers desire them for shipping to Boston, New York, Philadelphia, Pittsburg, Baltimore, Cleveland, Albany, Detroit, and many smaller eastern cities. The Chicago packing houses use from about 50 to 60 per cent. of the beef cattle sold on the Chicago market, and the exporters and shippers from about 20 to 25 per cent. each. No statement can be made, however, as to the relative number sold either for dressed-beef or out-of-town slaughter that will be correct for any great length of time, as this depends

largely on the quality and the supply of the offerings, and to a considerable extent on the nature of the demand.

4. The beef-cattle class is made up of the following grades: *Prime steers*, *choice steers*, *good steers*, *medium steers*, and *common rough steers*. The bulk of the prime steers sold at Chicago weigh from about 1,200 to 1,600 pounds; the choice steers, from about 1,150 to 1,600 pounds; the good steers, from about 1,150 to 1,600 pounds; the medium steers, from about 1,100 to 1,400 pounds; and the common rough steers, from about 900 to 1,200 pounds. If fat heifers and cows are of good enough quality to grade as prime, choice, or good, they may sometimes be classed as beef cattle; medium and common rough heifers and cows are always classed as butcher stock, and even the prime, choice, and good grades are so classed except in cases where they are shipped to market in lots containing a relatively much larger number of steers. Spayed heifers usually bring within from 25 to 50 cents per hundredweight of as much as steers of equal quality and condition. Unspayed heifers and cows sell for considerably less than spayed heifers, because they are not usually in as good condition as the latter; they are likely to be pregnant, and when they are not their flesh will be dark if they are killed when in heat. Heifers and cows, when sold as beef cattle, are used mainly by the Chicago packers for the dressed-beef trade, although a small percentage of the best heifers are used for export. Heifers, as a rule, are too light in weight to justify the expense of exporting them.

5. Prime Steers.—Prime steers are steers that are practically above criticism as to both quality and condition. In fact, when the word prime is used in reference to any cattle it should be understood that the cattle are of the best grade of the class to which they belong, with the possible exception of a few fancy cattle of show-yard merit that occasionally reach the market. A prime steer shows conclusive evidence to sight and touch that it has in a high degree the form, quality, and condition demanded by the dealer in high-class beef. Prime steers are usually taken by packers, who want them for

the dressed-beef trade, and by buyers for the eastern markets, the latter taking the bulk of such cattle.

It frequently happens that a feeder tops the market for a particular day—that is, obtains the highest price of the day for his cattle—with rather a plain lot of animals. It also frequently happens that a lot of steers of prime quality does not bring the top price. In the first instance there was, doubtless, not a prime steer on the market, a condition not at all improbable; and in the second instance it is certain there was a liberal supply of prime steers, in which case the market-topping lot would have to be not only prime but fancy. Prime steers, then, not market toppers, should be the standard of excellence.

6. The butcher demands in a steer not so much the parallelogramic form commonly spoken of by many authorities, as he does a high state of development in loin, crops, back, thighs, twist, and rump. He demands development in these regions because they are the parts from which are obtained the high-priced cuts. The butcher demands, also, that a steer shall have plenty of depth and breadth, furnishing a large surface for flesh, without a tendency to be paunchy. He demands, further, that a beef animal shall have smooth, well-rounded general outlines, indicating both thickness and evenness of flesh, and a lack of tendency to be rough and coarse; a rough, coarse steer dresses out with a large percentage of waste to marketable beef. Then, too, the butcher is not unaware of the value of obtaining thick flesh in the region of the cheap cuts as well as in the region of the high-priced cuts.

To the untrained eye, an unusual development in the region of the valuable cuts might detract from the beauty, style, and gracefulness of an animal. To the butcher, however, such development would increase rather than lessen the value. It should be clearly borne in mind, therefore, that style, gracefulness of carriage, and beauty of outline never take precedence of proper development of the most important and valuable parts of a bullock. It should not be inferred, however, that the highest development in the most valuable parts is incom-

patible with ideal beef form; the truth of the matter is that high development is seldom found in the parts from which are taken the high-priced cuts, except in animals that are symmetrically developed.

7. Quality in a beef animal may be considered as: (1) general quality, and (2) quality of the flesh, and condition. General quality in a fat steer is indicated by a medium-sized, clean-cut head, bearing ears of moderate size and texture; short legs with clean, fine bone; a fine, nicely tapering tail; fine hair; pliable skin of medium thickness; and smooth, well-rounded outlines. Quality of the flesh depends largely on the condition of the animal—that is, on the degree of its fatness. It should not be assumed, however, that the highest quality of beef is found in the fattest steer; this is not the case. The best quality of flesh is found in a steer that is neither too fat nor too thin. There are three principal reasons for fattening a steer: (1) In order that when dressed there will not be a high percentage of offal and other waste, as a fat animal, other things being equal, will dress a higher percentage of carcass than a half-fat or a thin one, and, furthermore, in the fat animal the proportion of unsalable parts is reduced to the minimum; (2) in order that the flesh or lean meat shall be rendered more tender, juicy, and of better flavor by the deposition of fat throughout its substance; (3) in order to allow of proper ripening of the meat, as a thin carcass, being full of moisture and lacking the protection of a covering of fat, will rot before it will ripen.

Quality in flesh is influenced by the breeding and general quality of the animal. Methods of raising and fattening also affect the quality of the flesh. There is, however, a character or quality of flesh that is peculiar to the indivdual and independent of breeding and methods of feeding. Desirable quality of flesh is indicated by a firm yet mellow and springy consistency at the crops, along the back, at the loins, and even on the sides. It is indicated also by the absence of ties and rolls. A **tie** is a depression in the skin caused by the skin growing tightly to the bone. A **roll** is a patch of flabby fat

that is usually higher than the surrounding surface. A tendency to lay on fat in bunches and rolls at the loin indicates that the fat has been deposited in large masses and has not been evenly distributed throughout the animal so as to give the flesh the marbled character necessary to the highest quality in beef. An animal that has a tendency to lay on fat evenly may become bunchy about the tail head and show other indications of a lack of a well-marbled condition of the flesh if fed to the point of excessive fatness.

8. Undoubtedly, outstanding coarseness and lack of general quality in the live animal are inseparably linked with undesirable texture in the beef cut from such a beast. Fulness at the base of the tongue, fulness or a roll of fat in front of the shoulder point, fulness of the twist, mellowness of the cod, and a full rump and tail head indicate the degree of fatness that is essential to the highest quality of beef. These points, which are apt to be judged by sight rather than by touch, are the ones most depended on by buyers at the yards. If a close examination is desired, the ends of the fingers should be gently pressed into the flesh on the sides of the beast in an effort to find the ribs; there should be a firmness of flesh that does not admit of freely and easily forcing the fingers between them. A lack of firmness indicates the presence of too large a proportion of fat, which may be due either to a too fat, or overdone, condition of the animal or to an inherent lack of flesh, either of which is decidedly undesirable. A proper degree of firmness shows the presence of plenty of flesh, or lean meat. Such an examination reveals the quality of the surface flesh, but cannot always be relied on to determine the quality of the beef throughout the carcass.

It sometimes happens that a steer will not appear to be too fat before being slaughtered and yet be found excessively fat when put on the block. Animals that are carried to such an extreme degree of fatness as is seen in some show animals and occasionally among market animals, give evidence of an overdone condition by being very soft in flesh, a condition that often passes into one in which the flesh is hard and unyielding.

FIG. 1

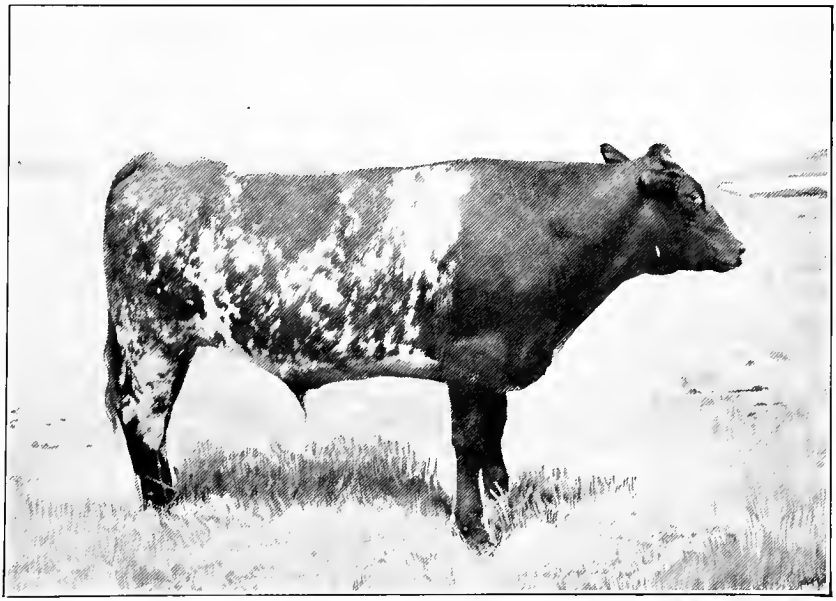


FIG 2

It sometimes happens, too, that certain animals become hard in the surface fat without ever having shown by softness of their flesh that they were approaching an overdone condition.

It is as difficult as it is unnecessary to decide whether form, condition, or quality is of the greatest importance to the butcher. The main point to bear in mind is that an animal deficient in any one of these points is disqualified to meet the full demands of the dealer in high-class beef and consequently is not considered a prime steer.

A prime steer is shown in Fig. 1. This animal has a good thickness of flesh, which is indicated by well-filled thighs, a full tail head, and general smoothness.

9. Choice Steers.—If a beef animal is not exactly right as to either quality or condition, but has in a marked degree the characteristics most sought by packers, shippers, and exporters, it is graded as choice. In order to be choice, steers cannot be much short of prime as to both quality and condition; in other words, they must have outstanding quality and condition. As the term indicates, a choice beef animal is choice, yet does not have the finish and quality found in a prime animal. A few choice heifers, if marketed in lots containing a relatively much larger number of choice steers, will often sell at a uniform price with the steers.

A choice steer is shown in Fig. 2. This animal lacks the condition and thickness of flesh shown by the steer illustrated in Fig. 1, but is superior in quality.

10. Good Steers.—A steer that is of good quality but noticeably lacking in condition or finish, or one that is finished or in prime condition but is deficient in quality, or one that is noticeably lacking in both quality and condition but is good enough to be above the average grade of fat cattle reaching the market, is graded as a good steer. The majority of good steers are a little coarse; they are in fat condition and of good weight, but are rather plain.

11. Medium Steers.—Steers of about average quality and condition but lacking to a marked degree the finish and quality

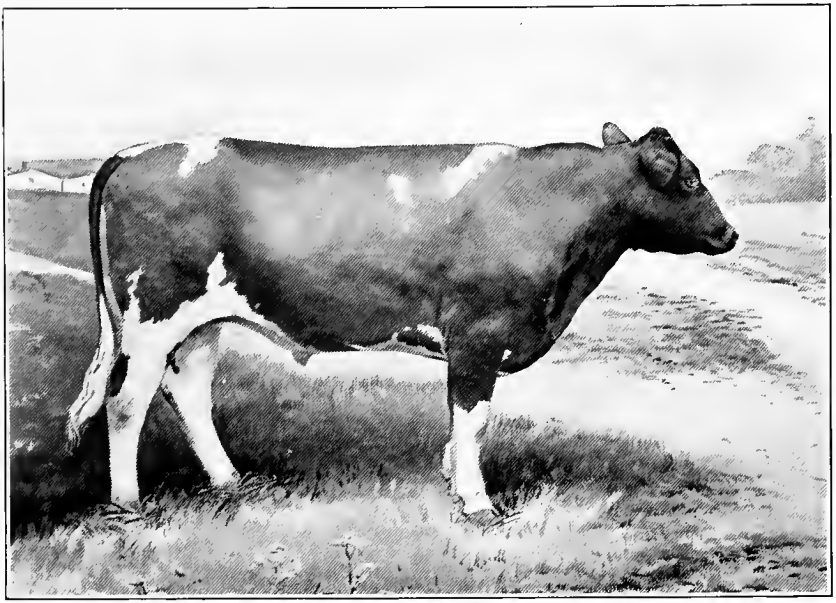


FIG. 3

FIG. 4

demanded in a prime steer are graded as medium steers. Steers of this grade are usually of light weight. They are generally too paunchy and too lacking in condition and quality to dress a high percentage of beef or to show a good proportion of fat. The beef from medium steers is not good enough to meet the demands of dealers in beef of the best quality, nor is the proportion of the high-priced cuts large; consequently, packers, shippers, and exporters cannot afford to pay for such steers the prices prevailing for prime, choice, and good steers.

In Fig. 3 is shown a medium steer. This animal shows coarseness, which is indicated by the drooping rump and plain head.

12. Common Rough Steers.—A great many common, rough, fat cattle are bought by packers and shippers for Pittsburg, Allegheny, Cleveland, Baltimore, and other markets. Such cattle are often called "pluggy" in the market, weighing from about 900 to 1,200 pounds. They lack both the quality and condition that characterize the better grades of fat cattle, being especially deficient in quality. These cattle are graded as common rough steers. As is indicated by the name of the grade, they are rough and coarse, and are not capable of taking on a high, smooth finish like steers of good quality. It would seem more consistent to class common rough steers as butcher stock, and they are often, although not always, so classed.

Fig. 4 shows a common rough steer that, although of beef breeding, lacks the depth of barrel and quarters required to make a good steer. Even with continued feeding such an animal would not develop.

BUTCHER STOCK

13. A large number of cattle of all grades as to weight and quality reach the market after having been merely "warmed up"—an expression used by cattlemen to designate the fact that cattle have been full fed but a short time. Then, no matter how carefully stockers and feeders are selected, there is almost sure to be a few animals that do not fatten satisfactorily. These, together with the better grades of heifers,

cows, and bulls, are classed as **butcher stock.** The butcher-stock class is made up of the following grades: *Prime heifers*, usually weighing from about 800 to 1,200 pounds; *choice heifers*, weighing from about 700 to 1,000 pounds; *good heifers*, weighing about the same as choice heifers; *medium heifers*, weighing from about 600 to 900 pounds; *prime cows; choice cows; good cows; medium cows; common rough steers; choice bulls; good bulls;* and *medium bulls.*

In general, very few steers of good quality are ever classed as butcher stock. A steer of good or choice quality that is not fat enough to be classed as a beef steer is classed among the better grades of stockers and feeders. Much better quality is found in butcher heifers than in butcher steers. Butcher stock, then, includes, so far as steers are concerned, only the poorer grades, such as common rough steers that may be classed as beef cattle, as butcher stock, or as stockers and feeders, depending on the supply and demand for the various classes of cattle. Owing to their lack of quality, they are seldom used as feeders.

The line between thin steers belonging to the butcher-stock class and fleshy stockers and feeders is not clearly defined. Whether a thin steer belongs to the butcher-stock or the stockers-and-feeders class will depend largely on the supply of cattle of the better grades, although the quality of the offerings may have some influence on the final disposition of such animals. If the supply of fat cattle is much short of the demand, buyers of cattle for slaughter are forced to take some of the thin animals that would ordinarily be classed as stockers and feeders; on the other hand, if there is a liberal supply of fat cattle some rather well-fleshed lots sell as stockers and feeders. In the former case, cattle of the thin grades are slaughtered and prices are paid for them that feeders do not see their way clear to pay; in the latter case, feeders are liberal buyers, owing to the moderate prices prevailing for such stock. The better the quality of the offerings the more likely they are to be used for further feeding. The majority of butcher-stock animals are heifers and cows. Animals of this class are looked on by cattlemen as by-products of the cattle-feeding industry.

FIG. 5

FIG. 6

14. Prime Heifers.—The same conformation, quality, and condition are demanded in prime heifers as in prime steers, which have already been described. In fact, prime heifers, if sold in lots containing a relatively larger number of prime steers, or if sold when there is a scarcity of prime steers, are often classed as prime beef cattle. Under normal market conditions, however, prime heifers are classed as butcher stock. A prime heifer is illustrated in Fig. 5.

15. Choice Heifers.—Choice heifers are those that have quality and condition to a marked degree but lack the faultless quality and finish that characterize prime heifers. They are good enough to convert into the best grades of butcher's beef. In order to be classed as choice, heifers must show unmistakable evidence of having a high percentage of the blood of one or more of the breeds of beef cattle.

In Fig. 6 is shown a choice heifer. In conformation and quality this animal is superior to the one shown in Fig. 5, but the latter is a more desirable butcher animal because it has a greater thickness of flesh, which is indicated by the full tail head, the well-filled thighs, the low flank, and the general smoothness.

16. Good Heifers.—Good heifers may, and usually do, lack both condition and quality, although a heifer of choice quality might be classed as a good heifer simply because she is deficient in condition. Good heifers must have a conformation that indicates that they will dress out a good percentage of beef and fat.

A heifer that would grade as good is shown in Fig. 7. This animal is deficient in beef conformation as well as in condition and quality. The long, thin neck and head indicate poor feeding qualities and the rough shoulder and thin thigh indicate a deficiency in covering of flesh.

17. Medium Heifers.—Usually, heifers must have better quality and conformation and be in better condition than steers in order to grade as medium. Medium heifers seldom show much quality and invariably show a decided lack of flesh.

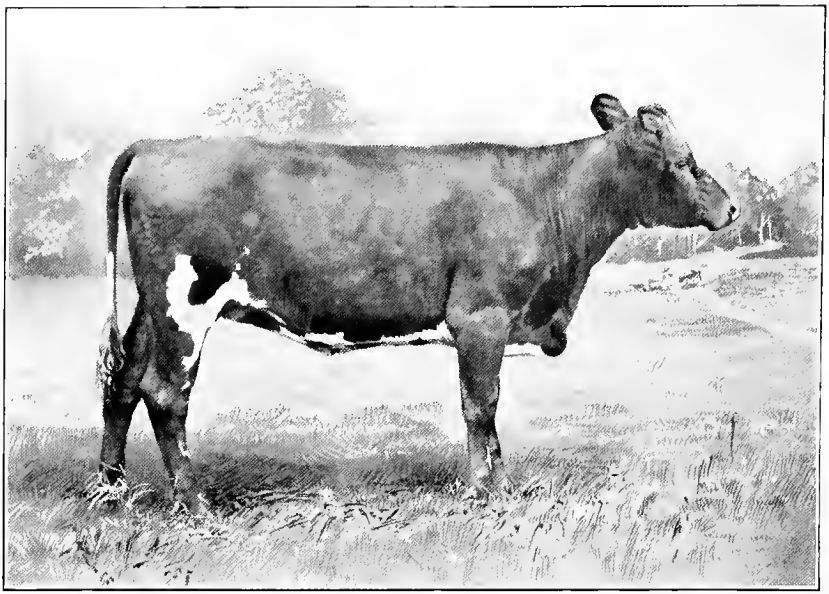


FIG. 7

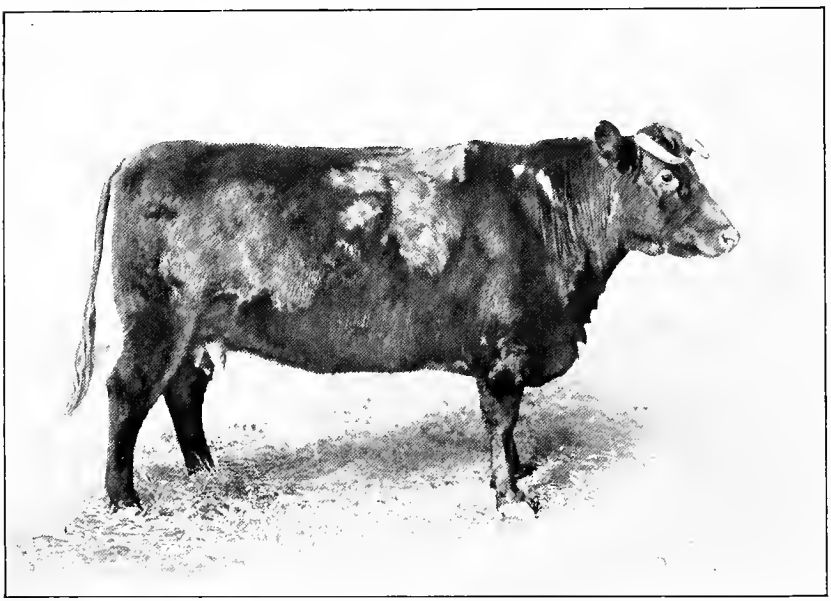


FIG. 8

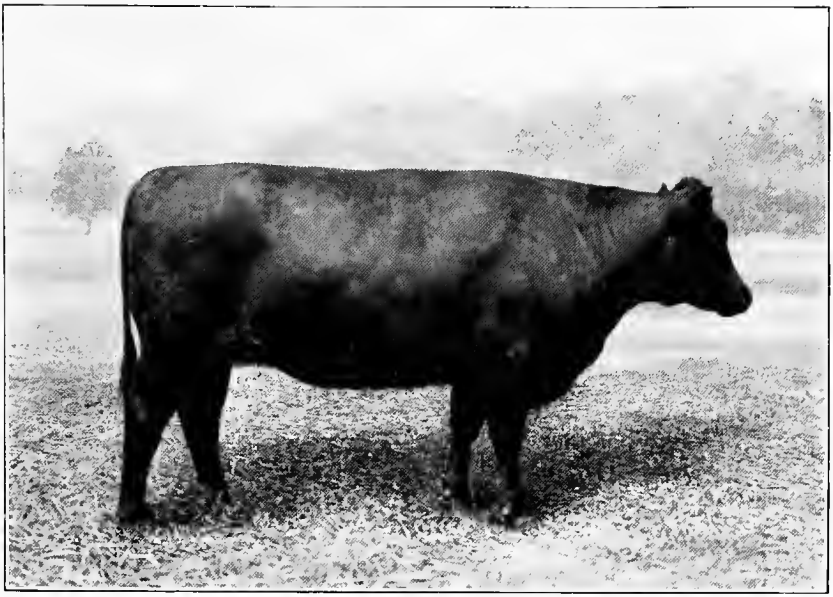


FIG. 9

FIG. 10

The majority of medium heifers, like medium steers, are light in weight.

18. Prime Cows.—Prime cows are those that are strictly fancy, well bred, and in prime condition. They are practically above criticism in conformation, quality, and condition. Such cows are often exported or used by packers for the same purposes for which steers are used. A very small number of prime cows reach the market.

In Fig. 8 is illustrated a prime cow that is typical of this grade. This cow has excellent beef conformation, good quality, and good condition.

19. Choice Cows.—In order for cows to grade as choice, they must be in prime condition, but may lack some of the quality and breeding shown by prime cows. Choice cows are fit for export, and on some markets sell for nearly as much as choice heifers. Frequently a few choice cows are shipped to market in the same car with steers, in which case they often sell for as high a price as the steers and are used for the same purposes.

A choice cow is shown in Fig. 9. This animal is in lower condition than the cow shown in Fig. 8 but is capable of as much finish.

20. Good Cows.—Good cows are deficient in both condition and quality. They are fat enough, however, to make carcass beef and have a conformation that indicates that they are reasonably good killers. In order to bring an average market price, they must, of course, be considerably better than the average butcher-stock cows.

A cow of the good grade is shown in Fig. 10. She has good quality but lacks in condition and depth of flank.

21. Medium Cows.—Medium cows are sometimes called beef cows in order to distinguish them from cutters. Such cows are decidedly lacking in form, condition, and quality. They belong to the lowest grade of cows, the carcasses of which may all be used to sell over the butcher's block.

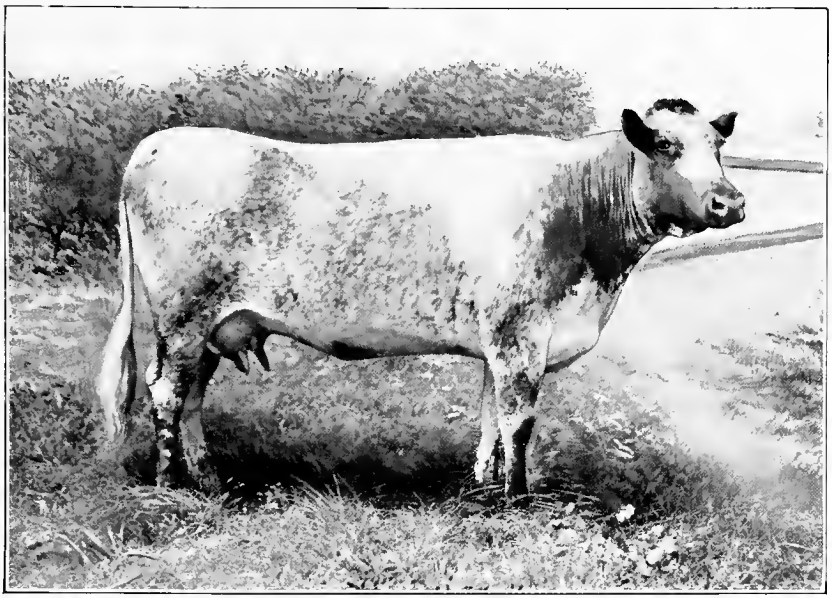


FIG. 11

FIG. 12

A medium cow is shown in Fig. 11. She gives evidence of being of good beef breeding and conformation but lacks in condition and thickness of covering. The low back is an indication of thinness of loin.

22. Common Rough Steers.—Steers of the common rough grade are very noticeably lacking in form, quality, and condition. Generally speaking, a lack of quality is the most apparent defect in animals of this grade. Common rough steers are frequently classed as beef cattle and have already been described and illustrated.

23. Choice Bulls.—In order to be choice, bulls must have quality and finish to a high degree. Comparatively few choice bulls reach the Chicago market, and when they do they are frequently bought for export. About one-third of the choice bulls are used for dressed beef. They must be entirely free from the roughness and coarseness that characterize many aged bulls. The supply of choice bulls is made up largely of old bulls.

A choice bull is shown in Fig. 12.

24. Good Bulls.—Good bulls have a high percentage of the blood of beef breeds, or at any rate they carry the flesh and show the conformation that usually accompany well-bred beef bulls. They are frequently lacking in both quality and condition, but a decided lack of either may furnish a sufficient reason for their being classed as medium and not as good bulls. Bulls of this class are often exported.

A good bull is shown in Fig. 13.

25. Medium Bulls.—Medium bulls lack to a marked degree both condition and quality. They are usually low fleshed, long-legged, coarse animals that are too good to be classed as either Bologna bulls or canners, but are inferior in both quality and condition. This is the lowest grade of bulls used for block beef. However, the line between medium butcher bulls and Bologna bulls is not definitely drawn. It varies from time to time with the demand for butcher stock and Bologna bulls.

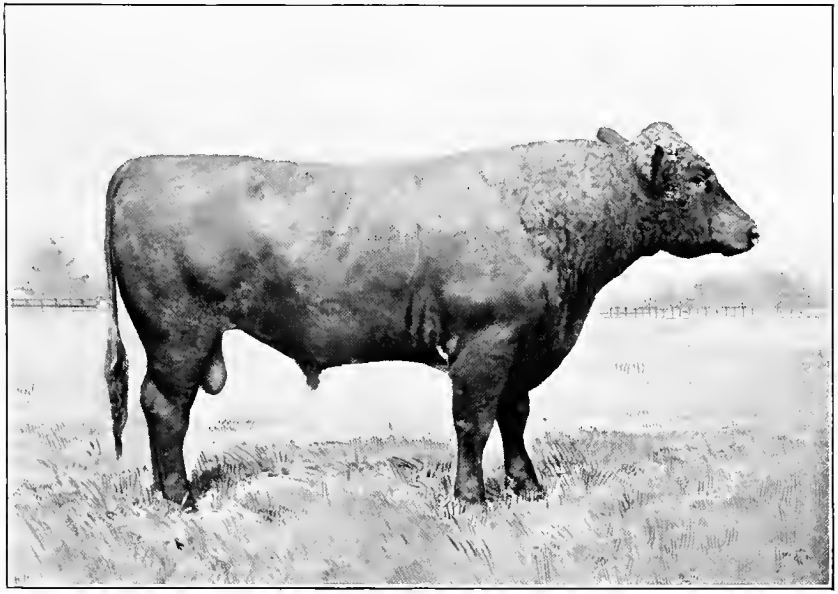


FIG. 13

FIG. 14

A medium bull is shown in Fig. 14. This bull, as compared to the one shown in Fig. 13, is low in quality; this is indicated by the coarseness of head and neck, the poor development of hindquarters, and the deficiency in flank and heart girth.

CUTTERS AND CANNERS

26. Thin cows, inferior steers, rough heifers, and the poorer grades of bulls, provided they carry sufficient flesh to allow of the loin or rib, or both, being used for cutting or for selling over the butcher's block, are classed as **cutters.** Cutters are a slightly better grade of cattle than **canners,** which are cattle of the same general class as cutters, but too inferior to allow of even a part of their carcasses being used for sale over the butcher's block. Canners are used mostly for canning. The class of canners and cutters and the grades within this class are more or less elastic and variable, as are all market classes and the grades within them. A thin, inferior animal that one day would be classed as a cutter would, on another day, be classed as a canner. As a general thing, a scarcity of beef cattle of all grades forces packers to use cattle for cutting and block purposes that would ordinarily be used as canners. Good cutters might be classed as butcher stock when such cattle are in strong demand and the supply is limited.

The bulk of cattle classed as cutters and canners may be graded as follows: *Good cutters, medium cutters, common cutters and good canners, medium canners, inferior canners,* and *Bologna bulls.* The impression prevails among persons unfamiliar with the cutter-and-canner trade that only old, thin cows are classed as canners. This is an erroneous impression, as wretchedly thin bulls, steers, and heifers are included as well. No other market class of cattle is so difficult for cattle buyers to judge correctly in making purchases. Some cutters and canners will dress out 60 per cent. of beef and others will dress out only 35 per cent. or less; consequently, it is necessary for buyers to study the offerings closely, if they are to secure a profit from the animals they slaughter. Cutters and canners generally give a high percentage of offal when being

FIG. 15

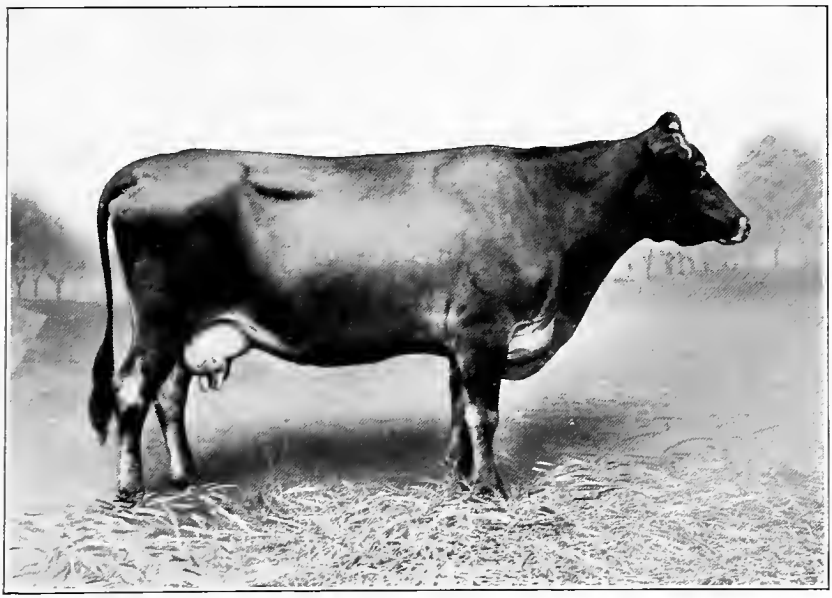


FIG. 16

dressed. To make proper allowance for this, buyers discriminate against excessive paunchiness even when the quality and condition are otherwise satisfactory.

27. Good Cutters.—Cattle that are a little too inferior to be classed as medium butcher stock are graded as good cutters. Such cattle lack the conformation and flesh that are found in animals suitable for the butcher. The majority of the cattle sold in this grade are dairy cows that carry some flesh, but not enough to warrant an attempt to use all of it as carcass beef.

Three good cutters are shown in Fig. 15.

28. Medium Cutters.—Low-grade cattle that are noticeably lacking in flesh or those that have a conformation indicating very inferior dressing qualities are classed as medium cutters. Such cattle are slightly inferior to good cutters.

29. Common Cutters and Good Canners.—Cattle too inferior to be graded as medium cutters are graded as common cutters and good canners. Common cutters and good canners may be considered as the same grade, as they are between canners and cutters. The dividing line between the two is far from being definitely drawn, being determined by the supply of and demand for such stock rather than by the quality and condition of the offerings.

A common cutter and a good canner is shown in Fig. 16. The animal illustrated is a Jersey cow that is smooth in conformation and in fair condition, but that represents a dairy breed, the animals of which do not make a good grade of beef.

30. Medium Canners.—Cattle that are rough, angular, and decidedly devoid of flesh are graded as medium canners. Market conditions seldom, if ever, vary enough that medium canners are graded as cutters. An experienced buyer or salesman knows at a glance that such animals are canners and can never be considered as having enough flesh to be used for any other purpose.

A medium canner is shown in Fig. 17.

31. Inferior Canners.—Cattle that are too inferior to be classed as medium canners are graded as inferior canners.

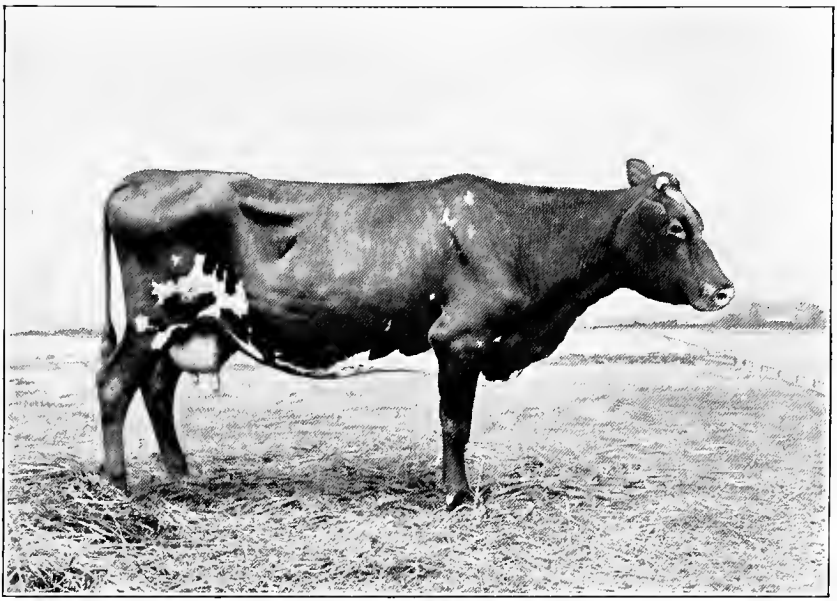


FIG. 17

FIG. 18

FIG. 19

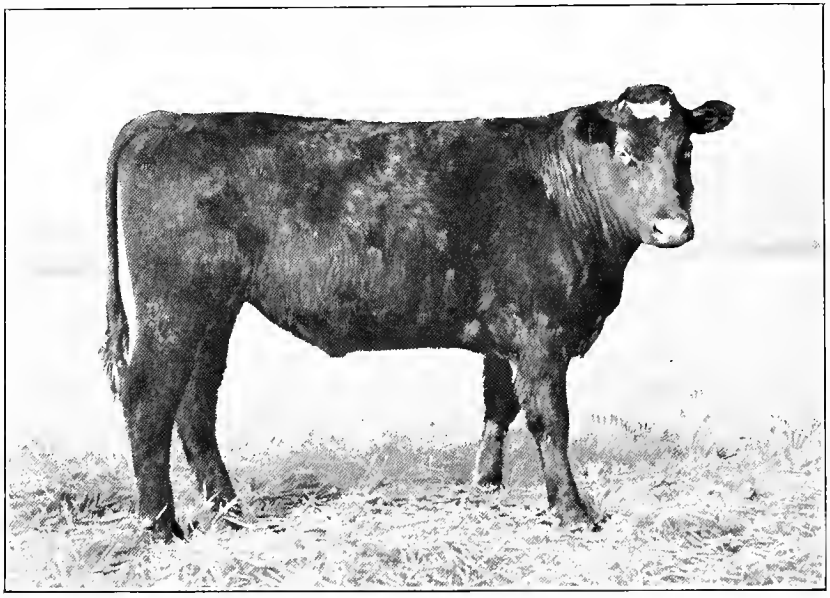


FIG. 20

They are referred to about stockyards as "dairy maids," "Nellies," "hat racks," and "skins." It is almost needless to say that they are wretchedly inferior animals.

Typical specimens of inferior canners are shown in Fig. 18.

32. Bologna Bulls.—Bologna bulls are a grade lower than medium butcher bulls, which have already been described. They lack the flesh and conformation that is manifestly characteristic of well-conditioned beef animals. In this grade there is a wide range of quality, flesh, conformation, and weight. The grade includes all bulls between medium butcher and canner bulls. A part of the loins and ribs of Bologna bulls are used for block purposes, hence they would be classed as cutters rather than as canners.

A Bologna bull is shown in Fig. 19.

STOCKERS AND FEEDERS

33. The class **stockers and feeders** include calves, yearlings, 2-year-olds, and older cattle. When it is necessary to refer to steers or bulls 18 months old or older that are intended for immediate use in the feed lot, they are spoken of as **feeders.** Calves, heifers, and young steers, including yearlings, are referred to as **stockers.** Some difficulties are encountered, however, in attempting to draw a definite line between stockers and feeders. Cattle of the same grade, age, quality, and weight shipped to the country by two different feeders might not be handled at all alike; one feeder might use them as stockers and the other might place them in the feed lot for immediate feeding. It is obvious, therefore, that the use to which the cattle are put by the feeder is not entirely a correct basis for classification. A safer basis would be to let the combined factors of age, weight, and condition of the animals decide whether they should be classed as stockers or as feeders.

It is seldom that a steer weighing less than 800 pounds is placed in the feed lot; the common practice is to buy steers for feeders that weigh from 900 to 1,000 pounds or more. Such steers are usually 18 months of age or older. Steers

spoken of in the market as feeders are, generally speaking, in better flesh than stockers. As a rule, therefore, feeders may be classified as steers weighing 900 pounds or more, that are 18 months old or older, and that are fleshy enough to render an extended period of low feeding unnecessary. To be sure, some of the better grades of younger and lighter-weight cattle, which, under this system of classification, would be called stockers, are occasionally purchased for immediate use in the feed lot. This, however, is the exception and not the rule. In the interest of uniformity and because heifers going back to the country are more often used for breeding purposes than for feeding, all heifers in the stockers-and-feeders class will be considered as stockers.

34. The stockers-and-feeders class of cattle is divided into the following grades: *Fancy selected feeders*, *choice feeders*, *good feeders*, *medium feeders*, *common feeders*, *inferior feeders*, *feeder bulls*, *fancy selected yearling stockers*, *choice yearling stockers*, *good yearling stockers*, *medium yearling stockers*, *common yearling stockers*, *inferior yearling stockers*, *good stock heifers*, *medium stock heifers*, and *common stock heifers*.

The majority of fancy selected feeders weigh from about 900 to 1,150 pounds; choice feeders, 900 to 1,100 pounds; good feeders, 850 to 1,100 pounds; medium feeders, 800 to 1,050 pounds; common feeders, 800 to 950 pounds; inferior feeders, 800 to 900 pounds; feeder bulls, 1,000 to 1,200 pounds; fancy selected yearling stockers, 750 to 900 pounds; choice yearling stockers, 600 to 850 pounds; good yearling stockers, 550 to 800 pounds; medium yearling stockers, 550 to 750 pounds; common yearling stockers, 500 to 700 pounds; inferior yearling stockers, 400 to 650 pounds; good stock heifers, 600 to 700 pounds; medium stock heifers, 550 to 700 pounds; and common stock heifers, 450 to 600 pounds.

As quality or breeding largely determine the grade of an animal of this class, whether the animal is a stocker or a feeder, a description of the various grades of feeders will answer equally well for the same grades of stockers, excepting the grades of stock heifers.

35. Fancy Selected Feeders.—In order for cattle to grade as fancy selected feeders, they must be uniform in color, be of outstanding quality, and give evidence of having a large percentage of the blood of one of the improved beef breeds. Relatively few of this grade of stockers and feeders find their way to market. Breeders fortunate enough to own thinnish steers of such quality usually hold them until they are finished as prime bullocks, or sell them at home to feeders at good prices, avoiding the expense incident to shipping. Fancy selected feeders have all of the desirable qualities of choice and good feeders, and in addition are almost invariably better fleshed. They are to the stockers-and-feeders class what prime steers are to the beef-cattle class; in fact, fancy selected feeders, if properly handled, will develop into prime steers of market-topping quality. They are practically above adverse criticism.

A fancy selected feeder is shown in Fig. 20. This animal is a low-set, blocky steer of beef-breeding conformation, with a short, broad head and wide muzzle.

36. Choice Feeders.—In the class made up of stockers and feeders, the grade known as choice feeders is considered to be the standard. Steers of this grade will, under proper management, develop into choice and prime animals. They are not so good as fancy selected feeders, but inasmuch as only a few of the latter reach the market, the choice animals are of greater interest and importance to cattle feeders. For this reason, choice feeders will be described in detail as the type of steers that should be selected for feeding.

The qualities demanded in choice stockers and feeders are, first, the ability to develop into choice or prime beef animals, and, second, the ability to make economical gains in flesh and fat. Indications of these qualities are looked for in the form, quality, and constitution of the animals.

The general form should be low set, deep, broad, and compact rather than high up, gaunt, narrow, and loosely made. Stockers and feeders should be low set, or on short legs, because animals of this conformation are almost invariably good feeders and capable of early maturity. They should be deep, broad,

and compact, because this conformation indicates good constitution, capacity for growth, and for ultimately producing a relatively high percentage of the most valuable cuts. Feeders should have broad, flat backs and long, level rumps. They should have straight top and bottom lines, which should be nearly parallel; and should be low at the flanks, thus giving good depth, for the barrels of stockers and feeders should be roomy. An animal that is too paunchy, however, is objectionable to the butcher. The matter of low flanks should be emphasized, as it is almost an unfailing sign of good constitution and good feeding quality. It should be borne in mind that in both the stocker and the feeder, which are thin in flesh and largely destitute of external or surface fat, an excellent opportunity is afforded of determining the covering of natural flesh that is characteristic of the animal.

Feeders should have as much smoothness of outline as is consistent with low flesh, and there should not be too great prominence in the hips, tail head, and shoulders. Rough, open shoulders; sway backs; and large, coarse heads with small eyes set in the side of the head should be avoided. Short, broad heads and short, thick necks indicate strong tendencies toward beef making. A large, prominent, and mild eye is to be desired. Mild eyes indicate that an animal has a quiet disposition, which all cattle feeders know is particularly desirable in a steer intended for the feed lot. The distance between the eye and the horn should be short, and the horn should be flat and of medium fineness rather than round and coarse. The lower jaw should be heavily coated with muscle; and the muzzle, lips, and mouth should be large but not coarse.

It is well to distinguish between what might be called general quality and handling quality. By *general quality* is meant general refinement of external conformation. General quality is affected by nothing so much as by breeding; in fact, the two are very closely associated. Good quality is seldom found in a poorly bred steer, but is generally characteristic of a well-bred animal. The desirability of general quality cannot be too strongly emphasized. Although it is a character that involves many points and is difficult to describe, its presence

or absence is quickly discerned by the trained eye. It is this character in stockers and feeders more than any other that is depended on as indicating that an animal has within it the possibility of becoming a prime steer.

Cattle are said to have good *handling quality* when the skin is mellow and loose; a thick, mossy coat of hair of medium fineness and a moderately thick skin are also desirable. This condition indicates that the animal is in good health, or thrift, and that it is a good feeder and capable of beginning to gain as soon as an abundance of food is supplied.

The ability to select stockers and feeders that have the potential power to develop into prime steers is one of the first and most important points for the stockman to acquire. Profits in steer feeding come not so much from skill in feeding and management as from intelligent buying and selling. The profit resulting from an increase during the fattening period of the value per pound of the total weight of the animal is as important as that resulting from the method employed in the feeding and management. It is seldom possible to produce at a profit gains that do not increase the value per pound of the total weight of the animal.

37. The points indicative of good constitution have practically been covered in the discussion of conformation. Good constitution is indicated by a wide, deep chest; fulness in the heart girth; depth and breadth of body; and good handling quality. Although refinement of form, otherwise spoken of as general quality, is desired, the refinement should not be carried to the point of delicacy. Too much refinement indicates delicacy or a lack of constitution, and no animal lacking in constitution should find its way into the feed lot.

The desirable characteristics of beef form, quality, and constitution should be found in well-bred grade animals of any of the leading beef breeds. Good grade Herefords can usually be put on the market in the fewest number of days, but they suffer most from being carried beyond the point of ripeness: Shorthorns and Aberdeen-Angus grades, although a little slower to mature than Herefords, are in fully as strong demand

in the market; Aberdeen-Angus and Galloway grades may be carried longer on full feed than other breeds of beef cattle without indications of bunches or rolls of fat, which are strongly discriminated against in American markets. The selection of the individual should receive more attention, however, than the selection of the breed.

The question of age should not be overlooked. A thrifty young steer of good weight and in good flesh is to be preferred to an older stunted steer. It should be said, however, that a stunted steer of any age or weight in the feed lot is a profit destroyer. Uniformity in the color of feeders is desirable, but the mistake should not be made of getting uniformity of color at the expense of more important qualities.

A choice feeder is shown in Fig. 21.

38. Good Feeders.—Good feeders have only to a limited degree the beef blood, the thrift, and the conformation of choice or fancy selected feeders. It is not difficult to criticize them as being somewhat lacking in the most desirable characters of an ideal feeder. They may be too long in the leg, too narrow in the back, and either too light or too heavy in the bone. Frequently feeders so graded have a tendency to be a little rough and coarse. It is generally true, however, that steers of this grade that are kept in the feed lot until ripe or finished will, in such condition, grade at least as high as good beeves, and it is not at all impossible for them to become choice enough in condition to grade as choice bullocks. In Fig. 22 is shown a good feeder. This animal, although high class for the grade to which it belongs, shows less substance than the choice feeder illustrated in Fig. 21.

39. Medium Feeders.—Medium feeders are only average in quality and thrift. They are usually of lighter weight than animals of the good, choice, and selected grades. They generally have a large enough percentage of beef blood that their color is not objectionable. Their general appearance, so far as it indicates their quality and thrift, is rather against them, indicating that no matter how judiciously thay may be handled it will be the exceptional steer among them that will

FIG. 21

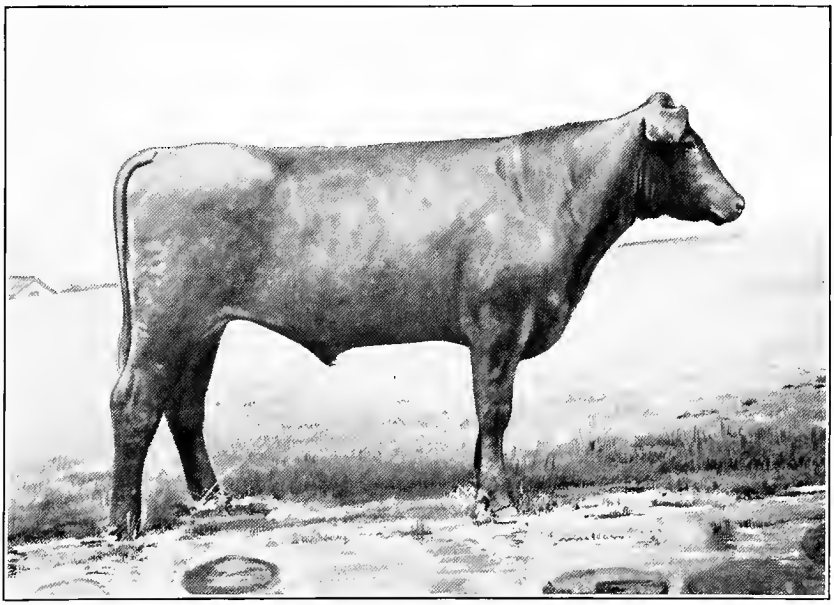


FIG. 22

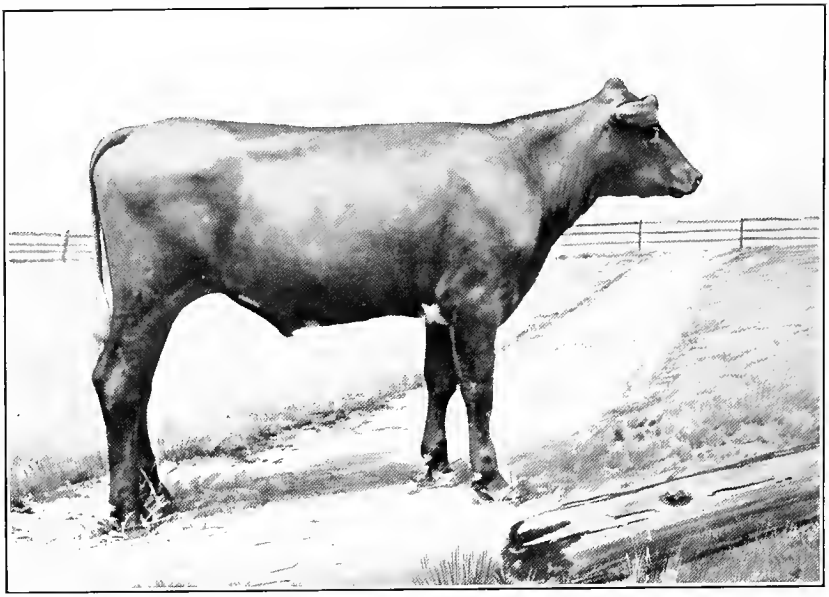


FIG. 23

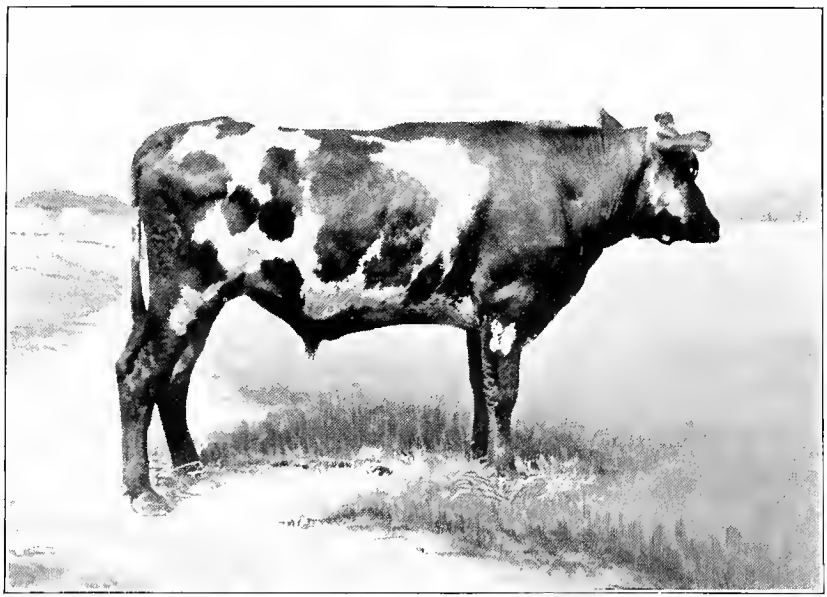


FIG. 24

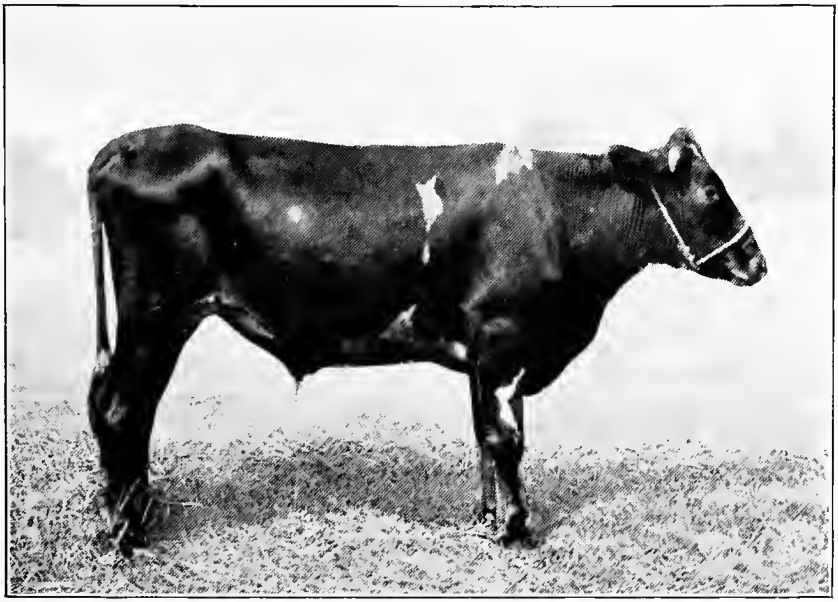


FIG. 25

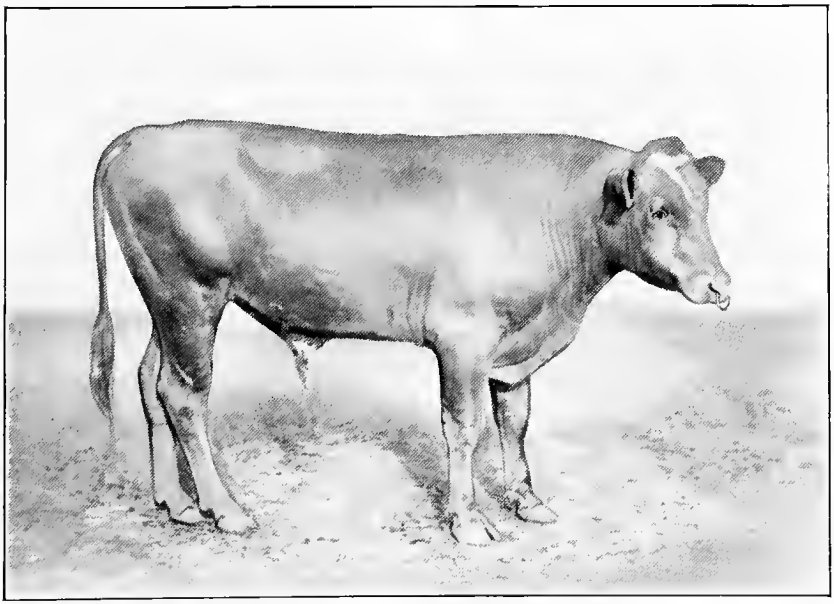


FIG. 26

develop into anything better than a medium or possibly a good bullock. It is seldom good practice to finish feeders of this grade.

A typical medium feeder is shown in Fig. 23.

40. Common Feeders.—A common feeder is decidedly deficient in quality; in fact, when the word common is correctly applied to any class of cattle it should be understood that the cattle referred to are noticeably deficient in quality, and that they are probably lacking in desirable conformation and flesh. As is true in the case of medium feeders, it seldom pays to attempt to finish common feeders.

A common feeder is shown in Fig. 24.

41. Inferior Feeders.—Inferior feeders are cattle of a grade lower than common feeders. It would seem that a feeder of a lower grade than common might more properly be graded as a canner than as an inferior feeder. As long, however, as there is a fair demand for inferior feeders, they cannot consistently be omitted from market quotations. Such feeders are rough and angular, with but little flesh, and have the conformation of a dairy-bred animal rather than a beef-bred animal. In the feed lot they are slow feeders and do not develop into satisfactory animals.

In Fig. 25 is shown a typical inferior feeder.

42. Feeder Bulls.—Feeder bulls are young bulls that are shipped to market in thin condition. They are of beef breeding and show unmistakable evidence of beef conformation, ample flesh, and thrift. They weigh from about 1,000 to 1,200 pounds.

A feeder bull is shown in Fig. 26.

43. Fancy Selected, Choice, Good, Medium, Common, and Inferior Yearling Stockers.—The description of fancy selected, choice, good, medium, common, and inferior feeders that has already been given applies to the corresponding grades of yearling stockers, and for this reason a description of the latter need not be given.

FIG. 27

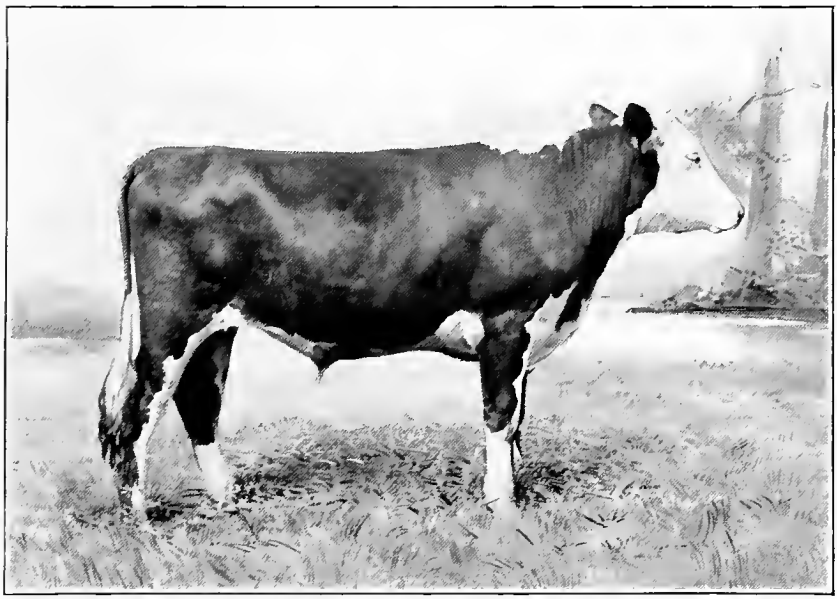


FIG. 28

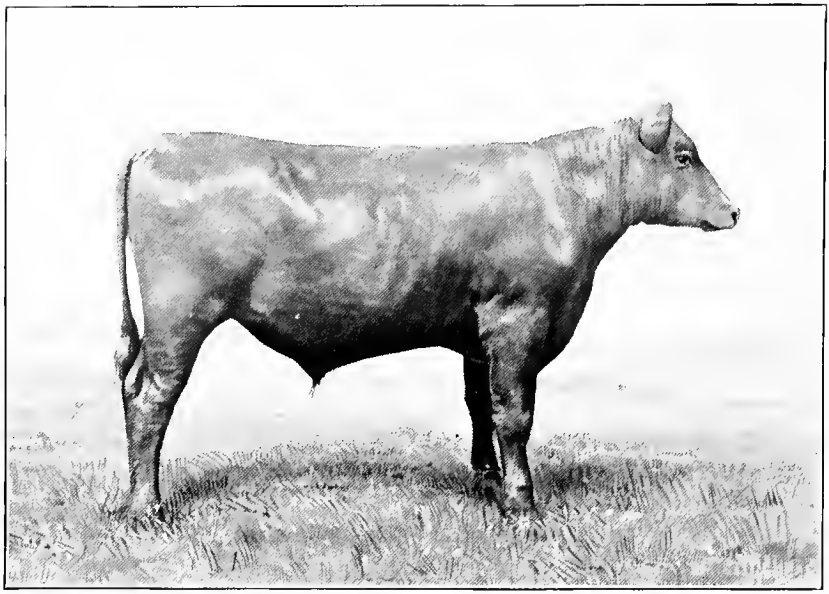


FIG. 29

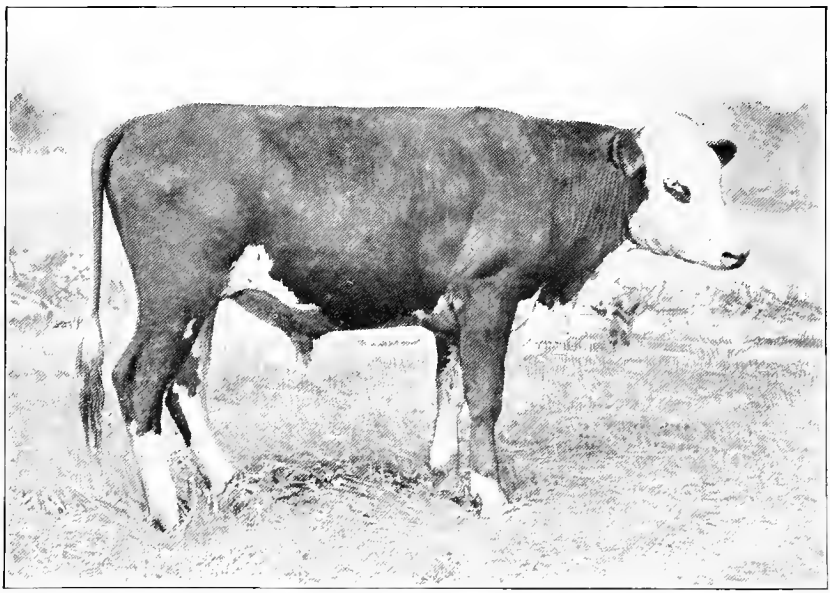


FIG. 30

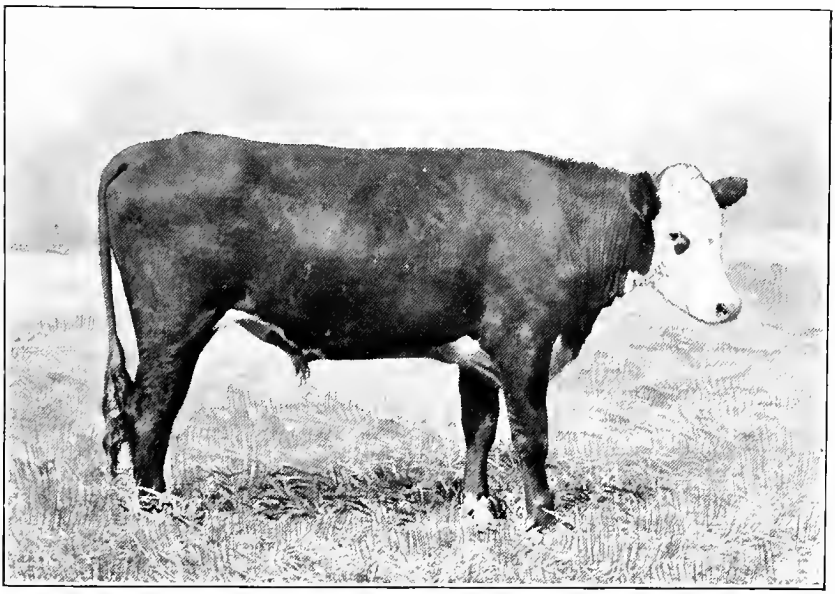


FIG. 31

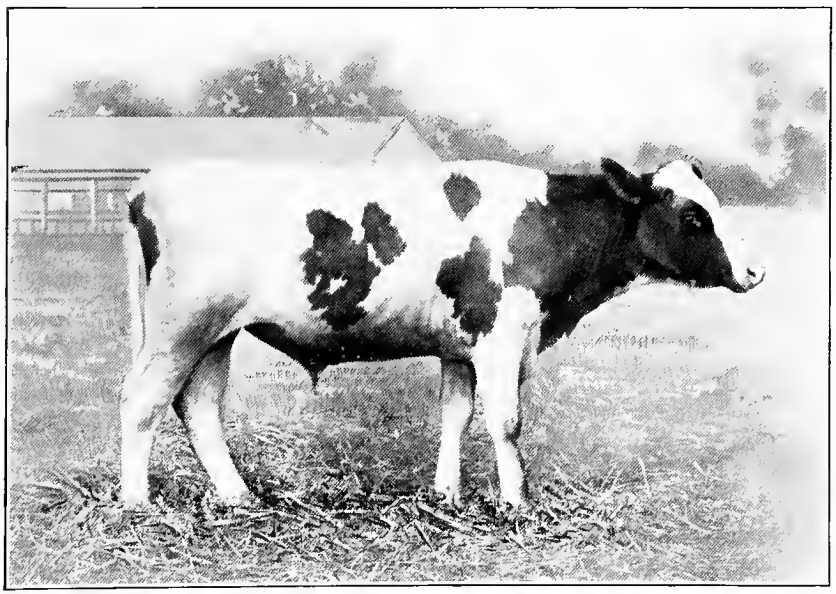


FIG. 32

In Fig. 27 is shown a fancy selected yearling stocker. The conformation of this steer is comparable to that of a fancy selected feeder but, for a maximum profit, the animal is too young to be placed in the feed lot. A choice yearling stocker is shown in Fig. 28. The markings on this steer indicate that it is a high-grade Hereford. It is smooth in conformation and has good quality but lacks the depth of body and the substance of the animal shown in Fig. 27. In Fig. 29 is shown a good yearling stocker. The slender neck and head denote poor feeding qualities; other deficiencies are the poor development of the hindquarters and the lack of sufficient heart girth. A medium yearling stocker is shown in Fig. 30. The drooping rump, coarse head, poorly developed hindquarters, and lack of depth in the hind flank indicate that the animal will not develop into a profitable feeder. In Fig. 31 is shown a common yearling stocker and in Fig. 32, an inferior yearling stocker.

44. Good Stock Heifers.—Relatively few choice stock heifers are sold on the market; consequently, the best grades of stock heifers to be considered here are good heifers. Stock heifers are bought to be shipped to the country both for the feed lot and for breeding purposes. Good heifers show considerable beef blood and have good, square frames. Such heifers are invariably in better thrift and condition than lower grades of stock heifers, yet they are hardly fleshy enough to be used as butcher stock. Whether a fleshy heifer is used as a stock heifer or for slaughter depends on the demand and prevailing price for butcher stock. A good stock heifer is shown in Fig. 33.

45. Medium Stock Heifers.—Medium stock heifers show less breeding and in general are noticeably thinner in flesh and lighter in weight than good stock heifers. They do not have the neat, blocky frames and the quality of the better grades of stock heifers.

In Fig. 34 is shown a typical medium stock heifer.

46. Common Stock Heifers.—Common heifers are invariably lacking to a marked degree in both quality and condition.

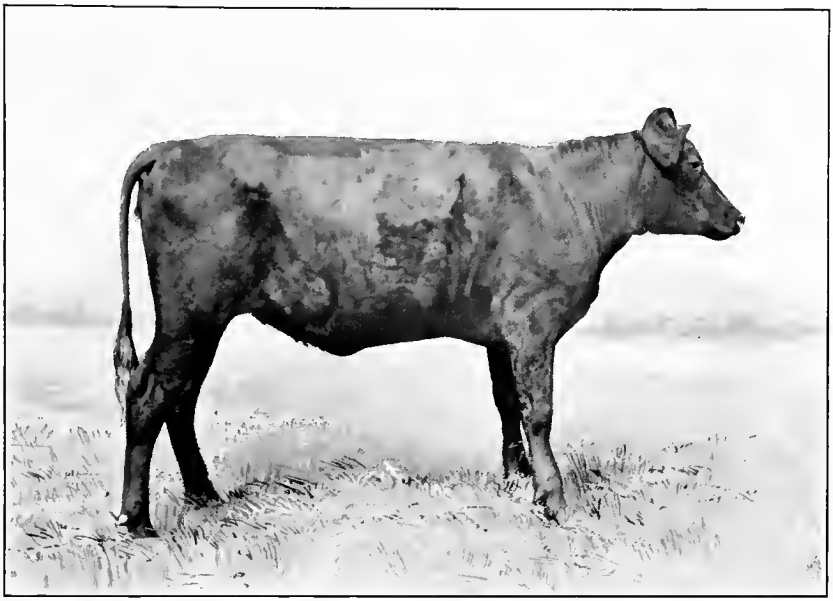


FIG. 33

FIG. 34

They are of lighter weight than the better grades of heifers and show evidences of dairy blood rather than beef blood. When such heifers are put in the feed lot and finished they

FIG. 35

seldom if ever grade better than medium to good butcher stock.

A common stock heifer is shown in Fig. 35

VEAL CALVES

47. Calves of suitable age, condition, and weight to sell, when slaughtered, as veal are classed as **veal calves.** Veal calves are graded as follows: *Choice veals*, *good veals*, *medium veals*, and *common veals*. Weight is not as important in determining the grade of a veal calf as age and flesh, although desirable weight in the good and choice grades of veals is important. A veal either 25 pounds too light or too heavy may be sold at a reduced price when one of the same quality,

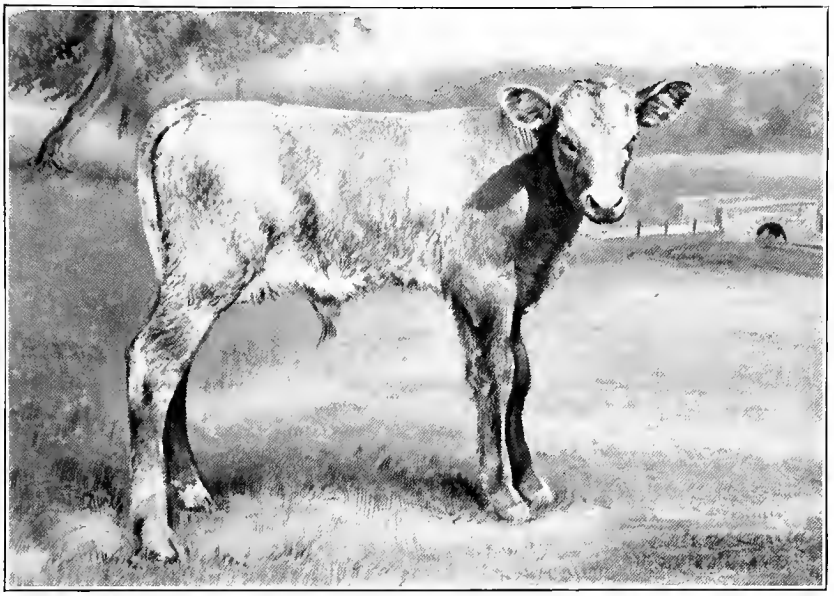


FIG. 36

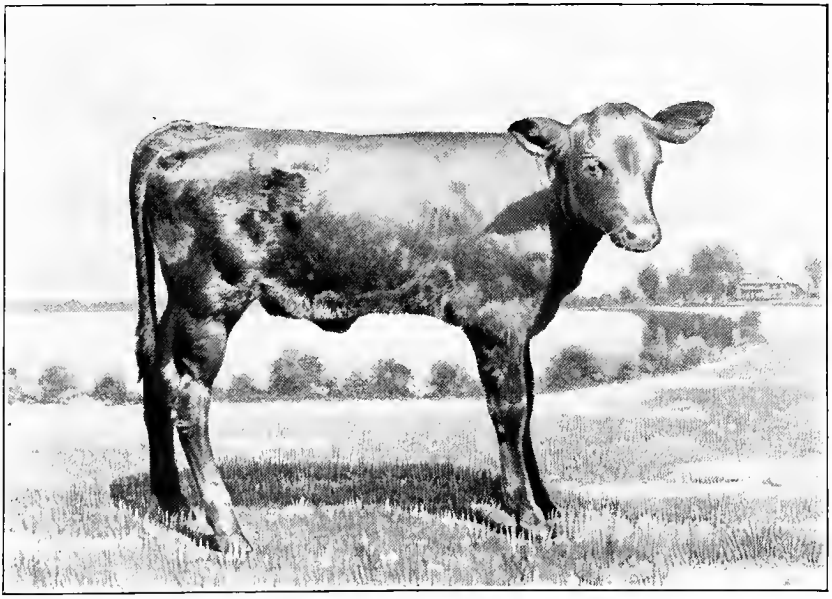


FIG. 37

age, and flesh, but of desirable weight, would sell as a choice veal. It is more difficult to distinguish breeding in young calves than in older cattle; it is fortunate, therefore, that the breeding of veals is of little importance and that the most important point is to get fine finish on a young calf—say a weight of from about 140 to 160 pounds, with faultless finish, on an 8-weeks-old calf.

48. Choice Veals.—In order to be choice, a calf must be fat and strictly fancy. It must not lack in condition or be either too young or too old, or too light or too heavy. The most desirable weight is 150 pounds and the most desirable age about 7 weeks. Choice veals range in weight from 120 to 160 pounds, and in age from 6 to 8 weeks.

A choice veal calf is shown in Fig. 36.

49. Good Veals.—The extreme range of the age and weight in good veals is somewhat wider than in choice veals, owing to the fact that as buyers can secure good veals at a lower price than choice veals, they are naturally less discriminating. Good calves vary in weight from 110 to 200 pounds and in age from 6 to 10 weeks. A calf that might otherwise grade as choice, but is a little advanced in age and of too strong weight, is classed as a good veal. A calf may be all right as to age and weight, but lack the fine finish of flesh necessary to be graded as choice.

Fig. 37 shows a good veal calf of excellent conformation.

50. Medium Veals.—Medium veals may be of the most desirable weight, from 140 to 160 pounds, but be too advanced in age for their weight and finish. They usually give evidence of having grown too slowly, owing to the lack of a proper or a sufficient supply of milk, or are too light in weight, having been sent to market before becoming fully ripe. Then again, calves of faultless flesh and conformation are often classed as medium because they have been held back too long, thus becoming too old and too heavy. It should be said, however, that the bulk of medium calves are too light in weight and too young, rather than too old and too heavy. Medium veals have the same

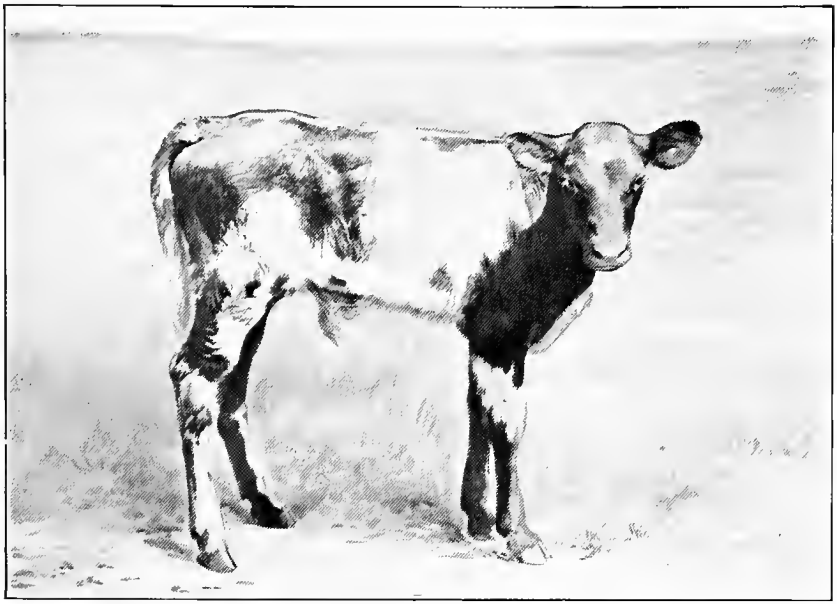


FIG. 38

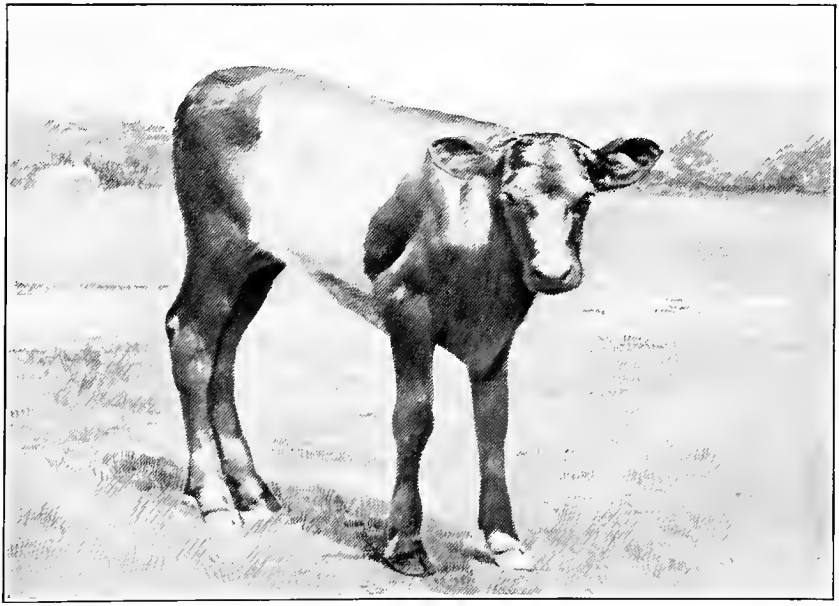


FIG. 39

242—35

faults as good veals, but these faults are more marked in the former. Medium calves vary in weight from 100 to 240 pounds and in age from 5 to 12 weeks.

A medium veal is shown in Fig. 38. This calf has especially poor development in the hindquarters.

51. Common Veals.—All thin calves except those too old to be classed as veals are spoken of as common veals. When too old and heavy to be classed as veals, calves are sold either as stockers or as butcher stock, depending on their condition. If advanced in age and thin enough to grade as common in condition, they would grade as stock calves. Whether calves of such age and condition are used for veal or stock purposes depends on the demand for veals and for stockers, and on the condition of the calves.

A common veal is shown in Fig. 39. This veal is smoother than the calves commonly found in the common grade but is overgrown.

MILKERS AND SPRINGERS

52. In the market, a cow with a calf at her side or a cow that is in milk is classified as a **milker.** A cow that is far enough advanced in pregnancy to give unmistakable signs of approaching parturition is termed a **springer.** As a rule, cows classed as milkers and springers are intended neither for slaughter nor for further feeding for beef production, but for dairy or breeding purposes. Many cows, however, that are shipped to market as milkers or springers and are not too far advanced in pregnancy are sold in the market as butcher stock, or as cutters, for more money than they would have brought as milk cows. The use to which an animal is put after being sold in the market is of no interest or importance to the shipper or the firm to which he consigns his stock. If, therefore, a milker or springer will net more to the shipper if sold as a beef cow, it is in line with good business practice so to dispose of her, for in so doing the commission firm satisfies the shipper.

MISCELLANEOUS TRADE TERMS FOR CATTLE

BABY BEEF CATTLE, DISTILLERS, AND TEXAS AND WESTERN RANGE CATTLE

53. The terms *baby beef cattle*, *distillers*, and *Texas and western range cattle* are commonly thought to refer to distinct classes of cattle, but in reality they are trade terms that are applied to certain kinds of cattle used for carcass beef. Baby beef cattle are of the prime and choice grades only, but distillers and Texas and western range cattle vary widely in quality and condition, their grades being the same as those of other beef cattle.

54. Baby Beef Cattle.—Steers that are between 1 and 2 years old, weigh from 800 to 1,000 pounds, are of prime or choice quality and condition, and have a conformation that indicates good killing qualities, are termed **baby beef cattle.** Such cattle are graded as prime or choice.

A baby beef steer is shown in Fig. 40 and a group of baby beef cattle in Fig. 41. The steers in the group are Shorthorn yearlings.

55. Distillers.—Cattle that have been fattened for market on the by-products of distilleries are known as **distillers,** or merely as **still cattle.** Formerly, feeders desiring feeding cattle to consume the residues of distilleries purchased only the poorer grades of feeding bulls, stags, and steers. Many feeders now, however, use a better grade of cattle for this purpose. When distillers are sent to the market they are preferred to other cattle of the same grades because they dress a higher percentage of beef, owing to the fact that they carry a small amount of offal, their paunches becoming reduced in size during the feeding. Distillers are used for dressed beef and export.

FIG. 40

FIG. 41

56. Texas and Western Range Cattle.—Cattle from Texas and the great western ranges are known as **Texas and western range cattle.** The range cattle that are raised in Texas or other southern states and brought North to be ranged for one or two seasons are often spoken of as *Montana-Texans*, *Wyoming-Texans*, *Dakota-Texans*, etc., according to the state in which they were last ranged; or in case exactness is desired, they are termed *wintered Montana-Texans*, or *double-wintered Montana-Texans*, as the case may be, to distinguish them from cattle that were bred on the northern ranges. All Texas and western range cattle are branded, and for this reason are sometimes spoken of as *branded cattle.* The strict interpretation of the term *western rangers* is western cattle shipped to the market from the range; they are often called *grass westerns.* The range season varies somewhat from year to year, but ordinarily begins about the middle of July and ends about the 15th of November. It is during this season that the bulk of grass westerns reach the market. There is another kind of western cattle, namely, *fed westerns.* These include range cattle that have been shipped into Illinois, Iowa, or other feeding states, and there fattened.

A few years ago Texas and western range cattle were a class as distinct as any reaching the Chicago market. They were distinguished by their long horns, long legs, thin flesh, narrow bodies, and large, deep brands. Today the noticeably long-horned range animal is rarely seen in the Chicago market. At the present time many Texas and western range cattle have such a high percentage of the blood of the improved beef breeds that such of them as are not of a polled breed, or dehorned, possess horns of short or medium length; thus, they attract but little attention and receive much less adverse criticism than formerly, when they were the butt of ridicule. They now frequently have the low-down, blocky form, which indicates that they have descended from the best strains of beef-producing cattle. They are often as well bred and as heavy in weight as native, or corn-belt, steers. The proportion of well-bred stock cattle in Texas and Western States is rapidly increasing. In view of these facts, therefore, the

term Texas and western range cattle is no longer necessarily indicative of an inferior grade of fat cattle, although it is true there is an exceedingly wide range between the best and the most inferior of these cattle.

The range in quality, condition, and price in Texas and western range cattle is greater, perhaps, than in any other kind of cattle reaching the market, the best steers occasionally showing the quality and finish of native steers, and selling for prices but little, if any, below the prices quoted for such cattle. In such instances they are, of course, used for the same purpose, except that they are seldom exported. Some Texas cattle have been exported from Galveston, largely, however, to Cuba. The lower grades of Texans sell as canners.

Quality, finish, and the method of feeding being the same, buyers make but little difference, say from 10 to 15 cents per hundredweight, between Texas and western range cattle and native cattle, although they try to discriminate against the former. Whether they are able to do so, and whether such discrimination has any effect depends on the available supply of fat cattle. Of course, there is always a slight discrimination against branded cattle on account of the brands injuring the value of the hides. There is less competition among buyers for Texas and western range cattle than for natives. In general, however, it may be said that Texas and western range cattle, if of the same quality and condition as native cattle, bring about the same price, except in the early season when grass is washy.

57. Texas cattle coming from north of the quarantine line established by the Federal government to prevent the spread of Texas fever, sell better than those coming from south of this line. Texas cattle coming from south of the quarantine line are sold in the Texas division, and those coming from north of the line and from the western ranges are sold in the native division. Western range cattle are classed with Texas cattle because they were formerly largely made up of cattle that had merely been wintered on ranges north of the quarantine line. Many, perhaps about one-half, of the cattle on the

ranges of the West and Northwest are now bred there; hence, the cattle coming from ranges are not altogether cattle that have been shipped there from Texas or other southwestern states. Then again, considerable feeding is now being done in the Southwestern States, due largely to the extensive use of cottonseed meal for fattening purposes. This, of course, has materially reduced the number of stock cattle for corn-belt feed lots available from southwestern ranges.

EXPORT, SHIPPING, AND DRESSED-BEEF CATTLE

58. The terms *export*, *shipping*, and *dressed-beef cattle* are generally understood to refer to market classes of cattle, but this is an erroneous impression, as these terms refer, rather, to the three principal uses made of cattle sold in the market for carcass beef. At present there are such wide variations in weight, quality, and condition of cattle used for export, shipping, and dressed beef that the terms export steers, shipping steers, and dressed-beef steers no longer indicate distinct and clearly defined types or grades of cattle.

59. Export Cattle.—By the term **export cattle** is meant cattle bought for export to the British or other foreign markets. The bulk of cattle exported belong to the good and choice grades of steers and weigh from about 1,200 to 1,500 pounds. As compared with the total number of beef animals exported, comparatively few prime steers are bought for export. Their relatively high price in American markets is prohibitive, or, at any rate, renders their exportation less profitable than that of the good and choice grades. For the Christmas market there is an active demand for a limited number of prime steers of rather heavy weight, say about 1,200 to 1,400 pounds. Although 1,200-pound steers are a trifle light in weight to meet the demand of exporters, they are often taken in preference to steers weighing 1,500 pounds or more, provided, of course, their quality and condition are satisfactory. If a weight were to be fixed on as being the most desirable for export cattle at the present time, it would be 1,350 pounds.

It is not at all strange that the public has come to look on export steers as being the best of American fat cattle, for they are generally above the average grade. An entirely erroneous impression, however, has become current among beef producers that nearly all of the prime steers are exported, leaving the cheaper grades for home consumption, and that none other than prime steers are exported. Cattle bought for the London market are invariably of a better quality and finish, as well as of heavier weight, than those purchased for the Liverpool and Glasgow markets; the latter take a cheaper, plainer grade than the former. The London market gets about a ship load of good to choice steers from the United States every week.

60. Shipping Cattle.—By the term **shipping cattle** is meant cattle that are purchased for shipping to New York, Boston, Philadelphia, and other cities. The bulk of shipping cattle are medium and good steers ranging in weight from 1,150 to 1,600 pounds, although buyers are always in the market for choice and prime steers. Buyers for the Boston market prefer steers that weigh from 1,500 to 1,600 pounds. Steers of good weight and of high quality and finish are eagerly sought by shippers and command good prices unless the supply is too great, as is sometimes the case during seasons when corn and other feeds are cheap. A relatively small number of shipping steers is wanted, however, as eastern buyers do not buy large numbers of cattle as compared with local packers; consequently, it frequently happens that there is too liberal a supply when feed is cheap. When such a condition exists, prices for good to choice heavy shipping steers are no better and sometimes a little less than for prime steers of the lighter grades, say from 1,200 to 1,400 pounds. The demand for this class of cattle is more constant and steady than the supply. Under normal conditions as to market and price of feed, there is a steady demand for such cattle at a strong price. Naturally, the packers need some heavy carcasses, but they are seldom obliged to make any special effort to buy them, as they obtain a sufficient supply from the various lots of cattle that they purchase. Boston is the best buyer on the Chicago market

for heavy steers, taking from ten to fifteen carloads per week. There is a limited demand the year round for prime 1,200-pound to 1,300-pound cattle for the high-class New York trade, and it may be said there is no market more discriminating as to quality and condition, nor any more willing to pay good prices for fat cattle that meet its requirements than the New York market.

61. Dressed-Beef Cattle.—The term **dressed-beef cattle** is used in reference to cattle that are used for slaughter by local packers. The grades of cattle used for dressed beef by the Chicago packers are so various that it is difficult to select those that could be fairly said to represent the types most in demand. There is a much wider range in weight, quality, and condition in cattle bought for Chicago slaughter than in those purchased for shipping or for export. Although perhaps no trade demands a better grade of cattle than packers, it is equally true that no trade can use so advantageously the medium and poorer grades. Generally speaking, packers will buy any kind of cattle if there exists a proper relation between the price per pound of live weight and the killing qualities of the animals. It is a question whether packers or eastern buyers are more discriminating as to quality and condition when both are in the market for prime bullocks. Packers have a steady demand throughout the year for the best grades of fat cattle to supply high-class local and out-of-town trade, but the demand for cheap beef from the mining and lumber camps makes it necessary for them to make extensive purchases of the cheaper grades of cattle. For the export dressed-beef trade packers buy well-fatted steers of the good grade ranging in weight from 1,200 to 1,400 pounds. When cattle are scarce and packers are short of the poorer grades they buy stockers and feeders or, in fact, any cattle that have fair killing qualities. The extreme range of weight in steers purchased for dressed beef would be from 800 pounds for good corn-fed yearlings to 1,700 pounds for steers of all grades. The greatest demand is for steers of from about 1,200 to 1,400 pounds weight of the medium, good, and choice grades.

THE BEEF CARCASS

62. A beef carcass consists of the two sides, or halves, of a beef animal that has been slaughtered for market. A carcass is cut into sections known as wholesale cuts; these cuts are sold by the wholesaler or the jobber to the retailer. The location of the wholesale cuts in an animal on foot is shown in

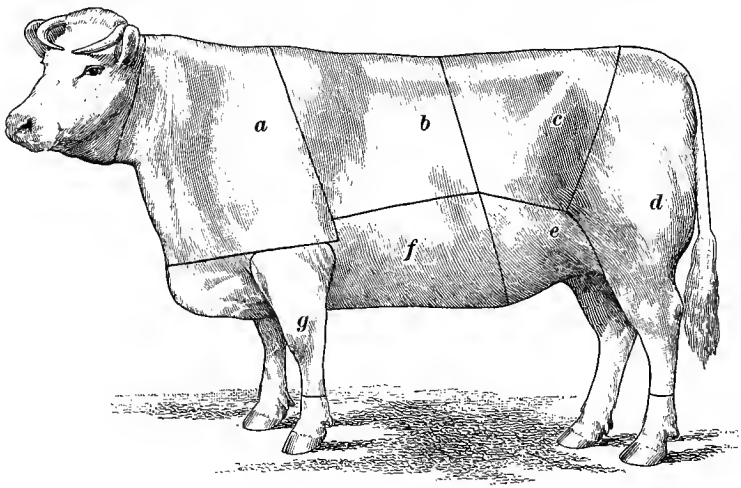


FIG. 42

Fig. 42, the cuts being: the chuck *a*; the rib *b*; the loin *c*; the round, with rump and shank on, *d*; the flank *e*; the plate *f*; and the shank *g*. In Fig. 43 is shown the location of the wholesale cuts in a beef carcass, a view of the internal side of one half of the carcass being shown at the left and a view of the external side being shown at the right; the wholesale cuts are shown and named in the right of the illustration and the corresponding cuts are shown at the left.

63. Description of Wholesale Beef Cuts.—The chuck cut is that part from the rear of the head to the fifth rib and from

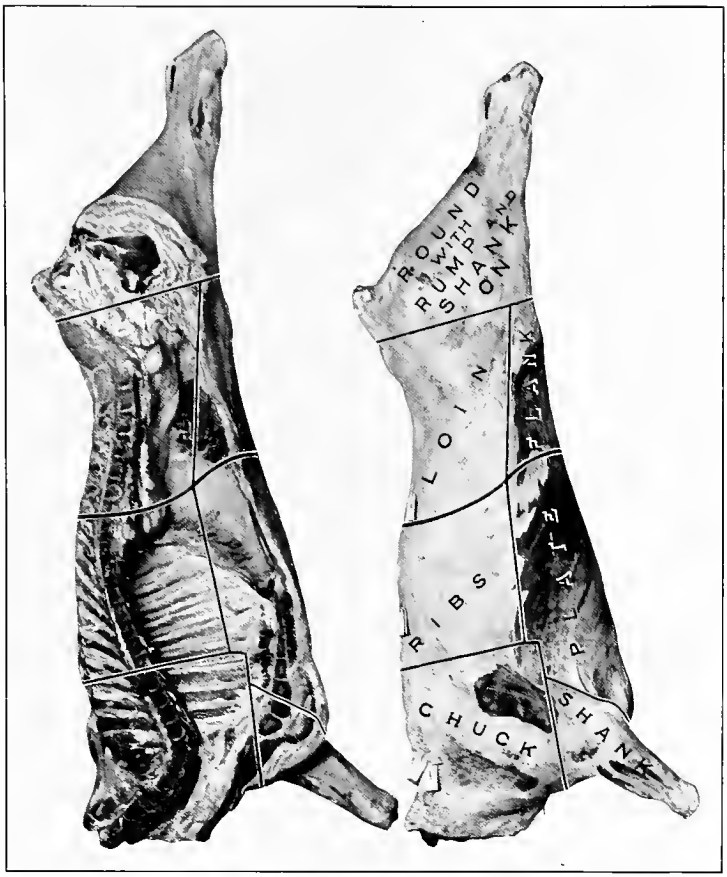


FIG. 43

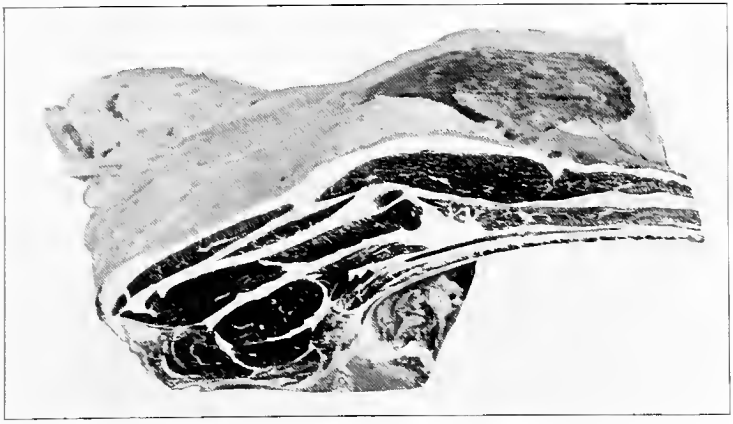


FIG. 44

the chine, or backbone, down to the plate and foreshank, thus consisting principally of shoulder beef. It ranks next below the round in demand and in market price, the meat being in a less suitable form for steaks and roasts, and is sold largely for boiling and stewing. The principal retail cuts are a rib roast,

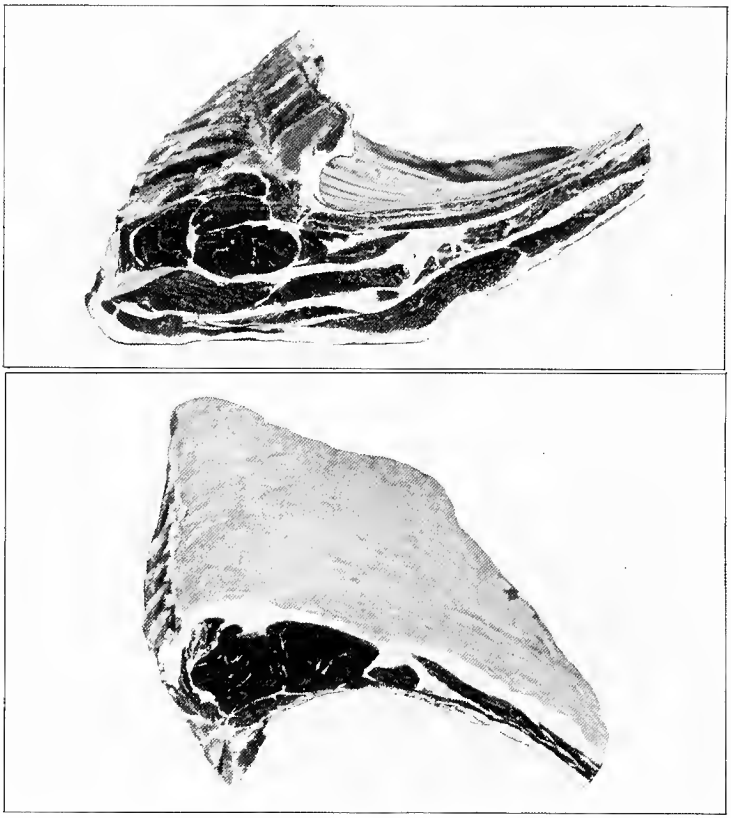


FIG. 45

chuck steaks, several pot roasts, knuckle soup bone, and neck. More or less chuck meat is used for the manufacture of sausage, mincemeat, and hamburger. The chuck cut is shown in Fig. 44.

The rib cut is that part of the carcass between the loin and the chuck and contains the upper part of seven ribs from the

sixth to the twelfth, inclusive. The first-cut rib roast, containing the eleventh and twelfth ribs, is considered the best of the retail cuts taken from the rib cut. In Fig. 45 are shown two views of the rib cut.

The loin is the choice portion of the beef carcass from the standpoint of tenderness and quality of meat; it is taken from a region of the body between the twelfth rib and the hip joint. Thus the loin cut includes the thirteenth rib, and is a region of the body in which the muscles are least exerted. Sirloin and porterhouse steaks are the retail cuts most commonly

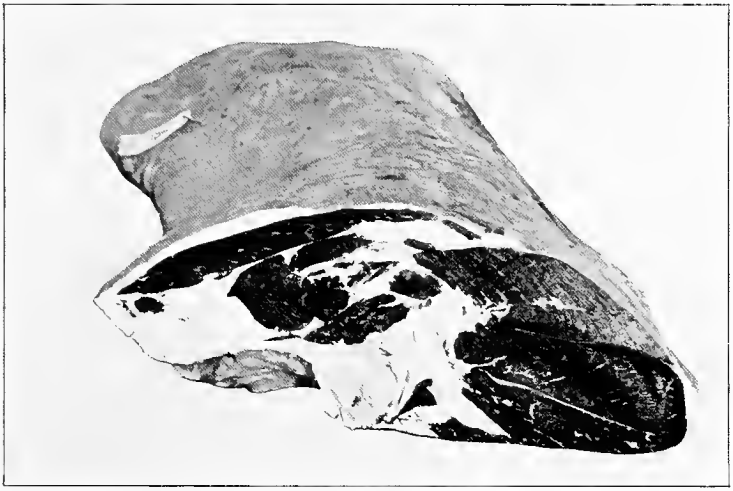


FIG. 46

made from the loin. The loin cut is illustrated in Fig. 46, the sirloin end, or end next to the hip joint, being shown.

The round cut includes the rump and hind shank in addition to the round proper; it is separated from the loin at the hip joint. When sold separately from the rump and shank the cut is termed a "round, R. and S. off," meaning a round from which the rump and shank has been cut away. It is primarily a steak cut, although well suited for roasting; the lower end, or heel of the round, is used as a pot roast or a boiling piece. Low-grade rounds are made into dried beef. The rump is

usually sold as a roast or as corned beef. The shank is cut up for soup bones. The round cut is shown in Fig. 47.

FIG. 47

The flank is a wedge-shaped piece cut from the lower part of the hindquarter and adjoining the loin. It is a boneless cut and, in high-grade beef, contains a large proportion of fat. Flanks are, for the most part, packed as mess beef, corned beef, or canned meat, or worked into sausage. The flank steak, or

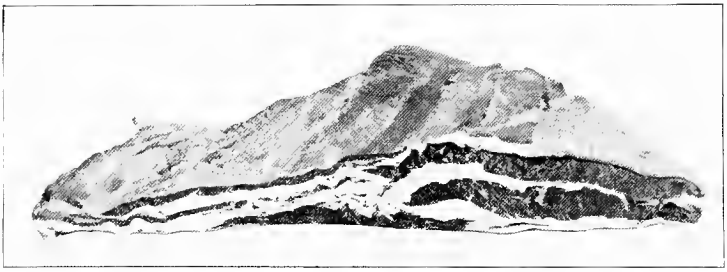


FIG. 48

butcher's steak, is also taken from this cut. The flank cut is shown in Fig. 48.

The plate cut includes the brisket and navel pieces, or in other words, the lower part of the forequarter. Fresh plate beef

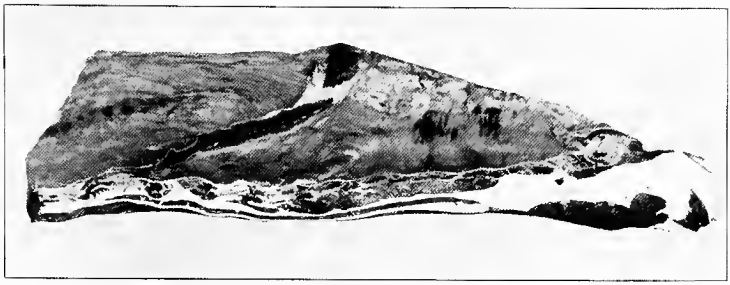


FIG. 49

contains a large proportion of fat and is suitable only for boiling, stewing, etc.; it is in very small demand in retail markets and is disposed of mainly as corned beef, mess beef, canned meat, and sausage. The plate cut is shown in Fig. 49.

The shank cut, or shin, is simply the fore leg cut off square from the lower edge of the chuck. What meat the shank carries is suitable only for soup meat, stews, hash, sausage, etc. The shank cut is shown in Fig. 50.

FIG. 50

64. Proportion of Beef Carcass to Live Weight.—In matured beef stock ranging in age from 2 years upwards the

proportion of dressed beef, or carcass, to live weight varies considerably with the grade of the animal. The grade, as has already been explained in the discussion of market classes and grades of cattle, involves both individual merit and condition, or degree of fatness. Show cattle, which are necessarily well bred and high in condition, dress from 65 per cent. to 70 per cent. of carcass to live weight, and in extreme cases even as high as 75 per cent.; prime market steers, from 60 per cent. to 65 per cent.; common beef steers, from 55 per cent. to 57 per cent.; butcher stock, from 50 per cent. to 60 per cent.; cutters, from 45 per cent. to 52 per cent.; and canners, from 40 per cent. to 45 per cent., in extreme cases but 35 per cent. The proportion of bone to meat, including both fat and lean, in choice prime steers is about 12 per cent.

JUDGING OF BEEF AND DUAL-PURPOSE CATTLE

JUDGING OF BEEF CATTLE

65. Method of Learning to Judge Beef Cattle.—In learning to judge beef cattle it is important that the beginner develop the faculty of judging by sight, as much as possible, rather than by handling. In the case of cattle there are few blemishes to look for and the body is not covered with wool, as in the case of sheep, which would necessitate careful handling. In fact, it may be said that there are but two points that can be ascertained about a beef animal by handling, namely, the condition, or fatness, of the animal, and the nature of the flesh. As a matter of fact, the trained judge is fairly safe in judging even these two points without resorting to handling.

The beginner in beef-cattle judging should first familiarize himself with the names of the various parts and exterior regions of a beef animal; the names of these parts and regions have already been given and illustrated. After a thorough knowledge of the different parts and regions has been acquired, the next step is to gain an idea of an ideal beef animal and the relative

importance of the various parts and qualities of such an animal as expressed numerically. For the purpose of assisting the beginner in obtaining a knowledge of these points, score cards are used.

66. Use of Score Cards in Learning to Judge Beef Cattle. A score card is a tabulated list of the parts, exterior regions, and general qualities of an animal, with such descriptive matter in regard to each part, exterior region, and general quality as will convey an idea of an ideal animal as a whole and the relative value of each part or point as expressed by a number. Score-card valuations are arbitrary, and, as might be expected from the fact that they are assigned by different judges, often differ in different score cards. This is of comparatively small importance, however, as the score cards serve their purpose satisfactorily even though they are not uniform in all cases. Score cards are valuable chiefly in two ways: first, they teach in a crude way at least the relative importance of the different parts of the beef animal, and second, they teach the prospective judge to look carefully at each point and not to overlook important considerations. The score card should be discarded, however, as soon as a judge becomes familiar with its use. The difficulty the beginner will find in using it is that he will be at loss to know how faulty the animal before him is and how to express its deficiencies numerically. The best way to overcome this difficulty is to form as correct an ideal as possible by studying the photographs of noted prize-winning beef animals, and, better still, by visiting fairs and farms where high-class beef animals are to be seen. A judge of cattle should never get so far advanced as to fail to take advantage of every opportunity to examine high-grade animals.

Different general classes of beef animals must be judged according to different standards. For example, stockers and feeders cannot be judged by the same standard that is employed in judging breeding stock. For this reason, score cards are given for three general classes of beef cattle, namely, market beef cattle, beef breeding cattle, and stockers and feeders.

SCORE CARD FOR MARKET BEEF CATTLE

Name or No. of animal.....

	Perfect Score	Judge's Score
Weight: estimated....pounds; actual....pounds; score according to age	10	____
Form: straight top and bottom lines; deep, broad, low set, compact, symmetrical	10	____
Quality: hair, fine; bone, fine but strong; skin, pliable; mellow, even covering of firm flesh, especially in region of valuable cuts; absence of ties and rolls	10	____
Condition: prime; flesh, deep; evidence of finish, especially marked in cod, at tail head, flank, shoulder, and throat; absence of bunches, patches, or rolls of fat	10	____
Head: clean, symmetrical; quiet expression; mouth and nostrils, large; lips, moderately thin; eyes, large, clear, placid; face, short; forehead, broad, full; ears, medium size, fine texture, erect	5	____
Neck: thick, short, tapering neatly from shoulder to head; throat, clean	2	____
Shoulder vein: full	2	____
Shoulder: well covered with flesh; compact	3	____
Brisket: full, broad, but not too prominent; breast, wide	1	____
Dewlap: skin not too loose and drooping	1	____
Chest: deep, wide, full	1	____
Crops: full, thick, broad	3	____
Ribs: long, arched, thickly fleshed	8	____
Back: broad, straight, thickly and evenly fleshed	8	____
Loin: thick, broad; thickness extending well forward	8	____
Flank: full, low, thick	2	____
Hooks: smoothly covered; width in proportion with other parts, but not prominent	2	____
Rump: long, level, wide and even; tail head, smooth, not patchy	2	____
Pin bones: not prominent, width in proportion with other parts	1	____
Thighs: full, fleshed well down to hock	3	____
Twist: deep, full; purse in steers full	4	____
Legs: straight, short; arm, full; shank, fine, smooth	4	____
Total	100	

SCORE CARD FOR BEEF BREEDING CATTLE

Name or No. of animal.....

	Perfect Score	Judge's Score
Weight: estimated....pounds; actual....pounds; score according to age	6	____
Form: straight top and bottom lines; deep, broad, low set, compact, symmetrical	10	____
Quality: hair, fine; bone, fine but strong; skin, pliable; mellow even covering of firm flesh, free from rolls; features, refined but not delicate; stylish	10	____
Constitution: chest, capacious; brisket, well developed; flanks, deep; bone, strong	10	____
Condition: thrifty, well fleshed, but not excessively fat; deep covering of firm flesh	6	____
Disposition: quiet, gentle	3	____
Color and markings: score according to breed	1	____
Muzzle: mouth and nostrils, large; lips, thin	1	____
Eyes: large, clear, placid	1	____
Face: short, quiet, expressive	1	____
Forehead: broad, full	1	____
Ears: medium size, fine texture	1	____
Neck: thick, short; throat, clean, according to breed	2	____
Shoulder vein: full	1	____
Shoulder: covered with flesh; compact	2	____
Brisket: well developed; breast, wide	1	____
Dewlap: skin not too loose and drooping	1	____
Legs: straight, short, set well apart; arm, full; bones, smooth, strong, being neither too coarse nor too fine	2	____
Ribs: long, arched, thickly fleshed	8	____
Back: broad, straight, thickly and evenly fleshed	8	____
Loin: thick, broad	8	____
Flank: full, even with bottom line	2	____
Hips: smoothly covered; width in proportion with other parts	2	____
Rump: long level, wide and even in width; tail head, smooth, not patchy	2	____
Pin bones: not prominent, width in proportion with other parts	1	____
Thighs: full, fleshed well down to hock	3	____
Twist: deep, plump, indicating fleshiness	4	____
Legs: straight, short, set well apart; bones, smooth, neither coarse nor too fine	2	____
Total	100	

SCORE CARD FOR STOCKERS AND FEEDERS

Name or No. of animal.....

	Perfect Score	Judge's Score
Weight: estimated....pounds; actual....pounds; score according to age	6	____
Form: straight top line; deep, broad, low set, compact, symmetrical	10	____
Constitution: heart girth, large; chest, capacious; barrel, roomy but not paunchy; bone, strong	8	____
Quality: hair, fine; skin, pliable and loose; even covering of flesh; bone, fine; features, refined but not delicate; head, clean cut and free from coarseness	10	____
Condition: medium; general thrift indicated by smooth hair, mellow skin, and clear eyes	4	____
Disposition: quiet and gentle, but not sluggish	2	____
Head: clean, symmetrical; muzzle, broad; mouth and nostrils, large; lips, moderately thin; eyes, large, clear, placid; face, short; expression quiet; forehead, broad, full; ears, medium size, fine texture, erect	5	____
Neck: short, blending neatly into shoulder; throat, clean	2	____
Shoulder: compact, free from coarseness	3	____
Brisket: well developed, breast wide	1	____
Dewlap: not too loose and drooping	1	____
Crops: full, broad; fore flank, full	4	____
Ribs: long, arched, smoothly fleshed	8	____
Back: broad, straight, evenly fleshed	8	____
Loin: long, wide, level, evenly fleshed	8	____
Flank: full, low	2	____
Hooks: width in proportion with other parts; not prominently wide nor high	2	____
Rump: long, level, wide; tail, smoothly set on	3	____
Pin bones: not prominent; width in proportion with other parts	1	____
Thighs: well fleshed, deep, wide	4	____
Twist: low	4	____
Legs: straight, short, set well apart; bones, smooth and strong; standing up well on feet	4	____
Total	100	

In using the score card for stockers and feeders, the beginner will find it helpful to visit, if possible, cattle feeders in his neighborhood who are raising or fattening beef cattle. The judging of animals of the various breeds of beef cattle calls for still further information; that is, in judging an individual beef animal, as a Shorthorn, a Hereford, an Angus, or a Galloway, the judge must look not only for the points of excellence that go to make up a typical beef animal, but also for the points of excellence that are characteristic of a particular breed. In order to acquire this information, the beginner should refer frequently to the descriptions already given.

67. Procedure in Judging of Beef Cattle.—After the beginner has become proficient in the use of the score card he should then attempt judging without it. In attempting to judge without the score card, a definite method of examination should be followed. The order in which the various points should be examined, however, is not so important as that the work should be methodically and thoroughly done. The following general method has been found satisfactory: Take a position in front of the animal at a distance of about 6 or 8 feet from it, and notice particularly the conformation of the head and neck and the breadth of the back as viewed from the front. Gradually move to the side of the animal, still keeping about the same distance from it, and observe whether the shoulders are smooth or rough; how the neck is joined to the shoulders; the length and set of the legs; the depth of the body; the straightness of the top and bottom lines; how the animal is developed in the fore flank, hind flank, and crop; the depth of the chest; the spring of the ribs; the smoothness at the hook bones; and the length and levelness of the rump. The rear view should be taken at closer range than the side and front views. This view gives the judge the best opportunity to judge of the evenness of the hooks, the filling of the thighs, and the nature of the flesh at the tail head. After the rear view is taken the animal should be moved slowly, the judge watching closely to note any weakness or strength that was not seen while the animal remained in one position.

68. For the purpose of giving a clearer idea of the procedure in judging cattle, a method of making a detailed examination of a fat steer will be given. The judge should take a position about 6 or 8 feet away from the steer to be judged. He should scrutinize the animal closely, paying particular attention to the refinement or coarseness of the features, the width of the forehead, the length and cleanness of the face, the size of the muzzle, the size and quality of the ears and horns, and the proportion of head to the rest of the body. The head should be short, broad, and refined; the muzzle, large and broad; and the jaw, strong. The ears and horns should be of fine texture and the features of the head should have a well-defined, clear-cut appearance; the head itself should be of proportionate size to the rest of the body. Objectionable things about the head are narrowness, extreme length, coarse features, a small, delicate muzzle, and lack of proportion in size between the head and the rest of the body. The head is often a good index of the qualities of an animal.

The judge should next move to a position a little to the right of the steer. From this point he should observe the width and smoothness of body, as shown in the chest, shoulders, ribs, back, loin, hips, and rump. The body should be broad and smooth. The chest should be wide and deep, and the fore legs short, straight, and standing far apart; the fore flanks should be full and not sunken behind the fore legs. The shoulders should fit smoothly into the body without a tendency to flatten on top or to show prominence of the shoulder blades. The body behind the shoulders should fit smoothly into them and be more than full enough in ribs, back, and loin to form a straight line from shoulder to hip. Any tendency to be flat in the rib or to be narrow or thin in back and loin should be discriminated against. The hips should fit smoothly into the body and be entirely covered by flesh, showing little prominence or unevenness, and the rump should carry out full and show no tendency to droop beside the tail head. The paunch must not be large and should be very little wider than the shoulder or thigh, because a large paunch means a large percentage of waste in dressing.

Passing farther around the animal so that a full side view is obtained, the judge should note the length and cleanness of the neck and the way it fits the shoulders at the shoulder veins, the general outline of the body, the top and bottom lines, the depth and fulness of the hindquarters, and the size and length of leg. The neck should be thick but short, thus avoiding a large quantity of cheap meat, yet indicating good muscular development throughout the entire body. It should be free from dewlap or heavy skin and an exceedingly large brisket, and should fit smoothly into the shoulder on both top and sides. The body, when viewed from the side, should present the general outlines of a rectangle, the top line being straight from head to tail, with no tendency to droop either in front or behind the shoulders or on the rump, or to sag or be low in the back. The bottom line should be low, straight, and parallel to the top line, showing no tendency to be high in the flanks nor too low in the middle, due to an excess of paunch. The brisket need be only large enough to fill out the outlines of the body, the chest should be deep and full, and the hind flank on a level with the lower line of the body; the body should stand on straight, short legs. The thighs should be deep, plumb, and full, and extend well down to the hock.

Moving toward the rear of the animal, the judge should note from the changing view point the different parts of the animal until a position in the rear is reached. From this position the judge should observe the depth and width of the hindquarters, the size of the paunch, the width and straightness of the back, and the smoothness of the hips and fulness of the rump. The hindquarters should be deep and as broad as the shoulders. The paunch or belly must be very little wider than shoulders or thighs. The back, as seen from the rear, must be straight and not droop behind the shoulders nor in front of the hips; it must be broad and thickly fleshed. The hips should be smoothly covered and show no prominence. The rump should be filled with flesh on each side and gradually round off smoothly from hips to tail head.

Passing around the animal on the other side, the judge should observe the various parts of the animal from all angles until

the right side is again reached, when the hands may be used to test the quality and thickness of the flesh. The best quality of flesh feels, under the pressure of the hand, to be firm yet elastic, and is free from any rough places such as rolls, lumps, patches, ties, and bare spots. Rolls are most commonly found on the ribs; lumps and patches usually occur on the back, ribs, and rump. These three defects are of the same nature, in that they are due to the fat having been laid on in larger quantities in some places than in others; they denote not only that there will be a loss when the animal is slaughtered, due to the excess of fat having to be trimmed off, but also that the fat is unevenly distributed through the lean, thereby lowering the quality of the meat. They can be easily detected by placing the hand on the flesh; if it is smooth, firm, and elastic it is of the proper quality; localized hardening of the fat, as if in pockets, indicates the presence of undesirable fat. Ties are commonly found on the back but occasionally around the tail head; they cause unevenness of flesh. Bare spots, or places where the flesh is very thin, are most liable to occur on the shoulder, loin, back, or lower ribs, and are due to an uneven distribution of flesh. The fingers should be pressed against the flesh, beginning on the shoulder and continuing toward the rear, in order to detect any of the defects just mentioned. The ideal flesh is even in all parts, and the hand can be moved over the body without a depression or rough place being found. Animals that have soft or harsh and inelastic flesh should be discriminated against. As a final step, the judge should feel the flank in order to see that it is so filled with fat that there is no loose, pendulous skin.

69. The Feeder's Ideal Animal.—In selecting an animal for the feed lot, the cattle feeder chooses one that shows evidence of having a capacity for large and economical gains. In order for an animal to be able to make profitable gains, it must have capacity for consuming a large quantity of feed. The feeder's ideal animal is first of all thrifty; it is in good health and has a vigorous constitution, as indicated by shortness of the head and neck, breadth and fulness in the chest

and heart girth, and bone of good quality but not too refined. Too much refinement in bone indicates either dairy breeding or delicacy of constitution, either of which is not desirable in a steer for fattening purposes. The nature of the coat of hair and the skin is another indication of the thrift of an animal. An unthrifty steer has a dull, coarse coat of hair, and the skin seems tight, harsh, and brittle when an attempt is made to gather it up in the hand. A good feeding steer should have a high percentage of the blood of the beef breeds, should be reasonably straight on the top and bottom lines, should be low set, and should have a deep body, showing capacity for the consumption of ample quantities of feed.

70. The Butcher's Ideal Animal.—The most profitable animal from the standpoint of the butcher is not necessarily one that has proved the most profitable in the hands of the cattle feeder. The butcher demands, first of all, that cattle shall be sufficiently fat to make high-class beef. It is true, as has already been explained, that there are several different grades of beef, and animals having but little fat are sometimes used as beef. Notwithstanding this fact, an animal, to be satisfactory to the butcher, must be fat. The profitable butcher animal should have a good conformation and a minimum of waste in head and bone, and be free from paunchiness. Such a conformation indicates that the animal will dress a high percentage of beef to live weight. The butcher, particularly, desires an animal to be well developed in the region of the valuable cuts.

JUDGING OF DUAL-PURPOSE CATTLE

71. The method of procedure in the judging of dual-purpose cattle is similar to that of judging beef cattle. Little attention has been paid to the judging of dual-purpose animals, except as representatives of a particular breed. Score cards for this class of cattle are not in use, so far as is known. In judging of dual-purpose cattle, it should be borne in mind that the type should approach as nearly as possible to the beef type without sacrificing altogether the tendency to produce a good

flow of milk. In other words, although the general conformation of the dual-purpose cow should approach the beef type, she should also show unmistakable signs of producing a good flow of milk. No cow has a right to be designated as a dual-purpose cow unless she would, when fattened, make a satisfactory carcass of beef, and when alive and fresh in milk give a profitable quantity and quality of milk.

A clear eye, clean-cut head and neck, and a slightly nervous temperament are characteristics of the best milk producers of any breed of cattle. There must also be a good development of all milking organs. The udder must be well placed, extending forwards as well as back, and should not be too fleshy. The teats should be of good size and well placed, as they are likely to be with a well-developed udder. The milk veins extending from the udder to small openings, termed milk wells, between the fore ribs are large and considerably crooked in good milkers.

BEEF AND DUAL-PURPOSE CATTLE

(PART 3)

EQUIPMENT FOR BEEF AND DUAL-PURPOSE CATTLE

BARNS

1. It is commonly understood that one of the functions of barns for livestock is to keep the animals warm, but authorities on beef-cattle raising are pretty well agreed that the principal purpose of a barn suitable for housing beef cattle, so far as the comfort of the cattle is concerned, is to shelter the cattle from storms and not to provide warmth. Hence, a barn or shed that is open to the south may be, in many respects, just as suitable for the purpose as one that is entirely enclosed. Naturally, young calves need more protection than an open shed affords, and this fact, coupled with the one that in a two-story barn there is a better opportunity for the storage of feed convenient for feeding, makes it justifiable to build a barn rather than a shed for beef-breeding cattle. The most desirable form or shape of barn will depend somewhat on the quantity and kind of feeds to be stored and the number of cattle to be accommodated.

If a man is engaged in or expects to engage in the raising of dual-purpose cattle it is likely that he will be able to make use of barns and other structures similar to those employed by

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY ALL RIGHTS RESERVED

dairymen for housing dairy cattle. Information pertaining to these structures and illustrations of various models will be found in a Section devoted to dairy barns and equipment.

LOCATION OF BARNS

2. The considerations that should be borne in mind when choosing a location for a barn for housing breeding cattle of the beef or the dual-purpose type are in the main identical with those that have been enumerated in another Section with reference to dairy barns. In a general way it may be said that one of the most important points to be considered is a location that will favor convenience in taking care of the herd. From this standpoint it is generally advisable to locate a barn for breeding cattle within easy access of other farm buildings, for such an arrangement will save labor and time in caring for the cattle. In some instances, however, individual raisers of beef or dual-purpose cattle have preferred to locate a barn at a point more or less removed from other barns and sheds, choosing for the purpose a sheltered place, as for example in a grove of timber. When such a course is followed it is usually because the location chosen is the most convenient on account of reducing the expense of handling crops that are to be fed to the cattle and also of reducing the labor of distributing the manure where it is wanted.

In selecting a location for a barn, due consideration should be given to placing the barn accessible to pastures and paddock spaces. A barn that is a considerable distance from pastures will often require the giving up of valuable land for lanes, and moreover the extra time and labor involved in getting cattle to and from the pasture will be a serious inconvenience at times. Often if a pasture were adjacent to or conveniently near the barn the cattle could have their freedom in the former for a short period, whereas if the pasture is not so located the cattle are obliged to remain in the barn.

MATERIALS FOR CONSTRUCTION OF BARNS

3. A comprehensive discussion of materials suitable for barn construction is contained in a Section on dairy barns and also in a Section on horse barns and paddocks, and it is scarcely necessary to repeat here what has already been said, since the questions involved are similar regardless of whether a horse barn, a dairy barn, or a barn for beef and dual-purpose cattle is to be built. Probably one of the chief considerations in determining the kind of materials that shall be used in the building of a barn for housing beef cattle is whether anything more than the suitable housing of the cattle is expected of the building. That is to say, a building for the proper housing of cattle may not be an expensive one, but if in addition to the proper housing of the cattle it is necessary or advisable to erect a building with reference to its appearance, this latter consideration may have an important bearing on the material selected. There is also the consideration as to whether the structure shall be one of a more or less permanent type or merely a temporary one. All frame structures are temporary in nature, although with proper selection of lumber and care in erection they may be made fairly permanent. In North America a very large majority of buildings for the purpose under consideration are frame structures, and largely because they can be more cheaply constructed than those of brick, stone, or concrete. On the British Islands nearly all similar structures are built of brick or stone, with roofs of slate or tile, and many of these structures have stood for over a century. In the United States and Canada the need for more permanent buildings and barns for beef cattle and other livestock, is everywhere apparent, and doubtless brick and concrete will be used more extensively in the future than in the past, particularly since the cost of lumber is constantly advancing.

4. Roofing Materials.—As pointed out in other Sections, there are numerous roofing materials that are satisfactory for use on barns, and the remarks appearing in these Sections regarding the suitability of different materials will apply in the present case.

Shingles are most commonly used for roofing purposes, and if a good grade of shingles is secured and they are properly laid they form about as durable roof, considering their cost, as anything on the market. Slate makes a more permanent roof but is heavy and expensive. Sheet iron, tin, and most of the different types of roofing paper, felt, or composition require frequent treatment to make them durable, but if they get the required attention they are, as a rule, satisfactory, and often where buildings of a temporary nature are needed they are to be advised in preference to more expensive roofing materials.

5. Flooring Materials.—In barns for beef and dual-purpose cattle the usual plan is to give the animals as much freedom as possible in open areas or in box stalls such as shown in the barn illustrated in Fig. 4. Often such areas comprise a large part of the ground floor of a barn and usually nothing more than a dirt floor is required. Many experienced men claim that a good stiff clay makes an ideal floor for this purpose. Obviously, this simplifies the construction of beef and dual-purpose barns with reference to floors. When single stalls are necessary, however, artificial flooring is required, and for this purpose concrete, brick, stone, planking, or cork brick are suitable. The relative merits of these materials have been discussed elsewhere, and a careful consideration of the requirements in a particular case and of the comparative cost in a given locality will usually determine which should be selected.

ROUND BARNS

6. Round barns have certain advantages over other types and are becoming more common throughout the country. A discussion of the advantages of round barns is contained in the Section devoted to dairy barns. The structure shown in Fig. 1 is a good example of typical round-barn construction. This elevation view is of a barn 60 feet in diameter and is designed to house forty head of cattle. The wall is of brick up to the second floor and the rest is of frame construction.

An elevated driveway gives access to the second floor as shown in Fig. 1. The room beneath this driveway may be utilized

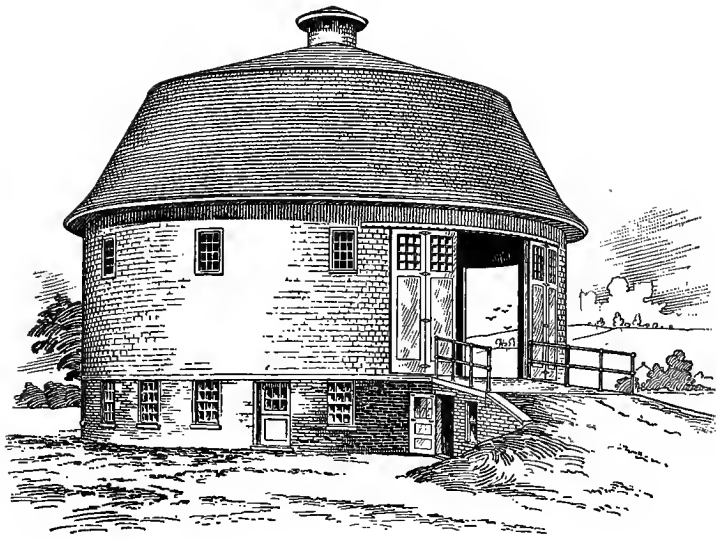


FIG. 1

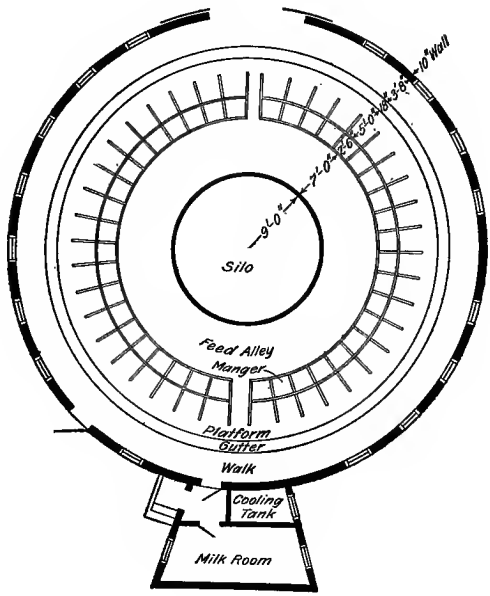

9'-0"
7'-0"
2'-6"
5'-0"
6'-6"
10" Wall
Silo
Feed Alley
Manger
Platform
Gutter
Walk
Cooling Tank
Milk Room

FIG. 2

for a milk room if dual-purpose cattle are kept or it may serve as a root cellar or general storage room if not required for the storage and handling of milk. In Fig. 2 is shown the first-floor plan, with details as to size and location of the silo, and the arrangement of stalls and milk room. The height of the silo is 48 feet, which gives it ample capacity for the storage of sufficient silage to feed forty head of cattle throughout the year.

RECTANGULAR BARNS

7. Judging by the relative number in use, the rectangular barn is the most popular shape of barn. One advantage it has over the round barn is the fact that it fits in more naturally

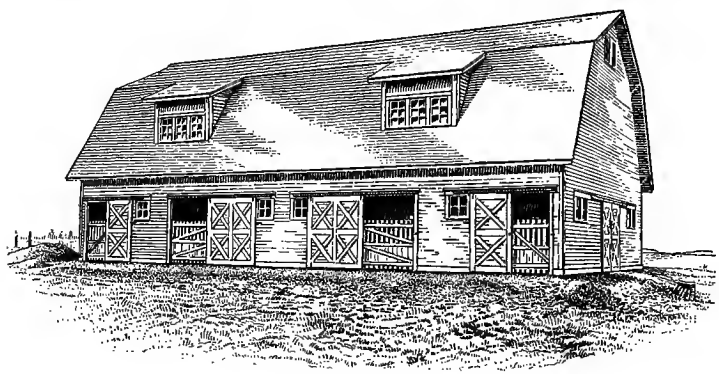


FIG. 3

and harmoniously with the type of architecture that is to be found on most farms. Although it is true that for a given amount of money more space can be enclosed with a round type of barn than a rectangular one, some farmers claim that this advantage is offset by the fact that it is easier economically to utilize all the space in the rectangular barn than it is in a round barn.

8. Medium-Sized Barn.—A rectangular barn that is well adapted to the needs of farmers engaged in raising beef or dual-purpose cattle is shown in Fig. 3. The structure is 74 feet 6 inches long and 46 feet wide, 9 feet high in the clear, 14 feet

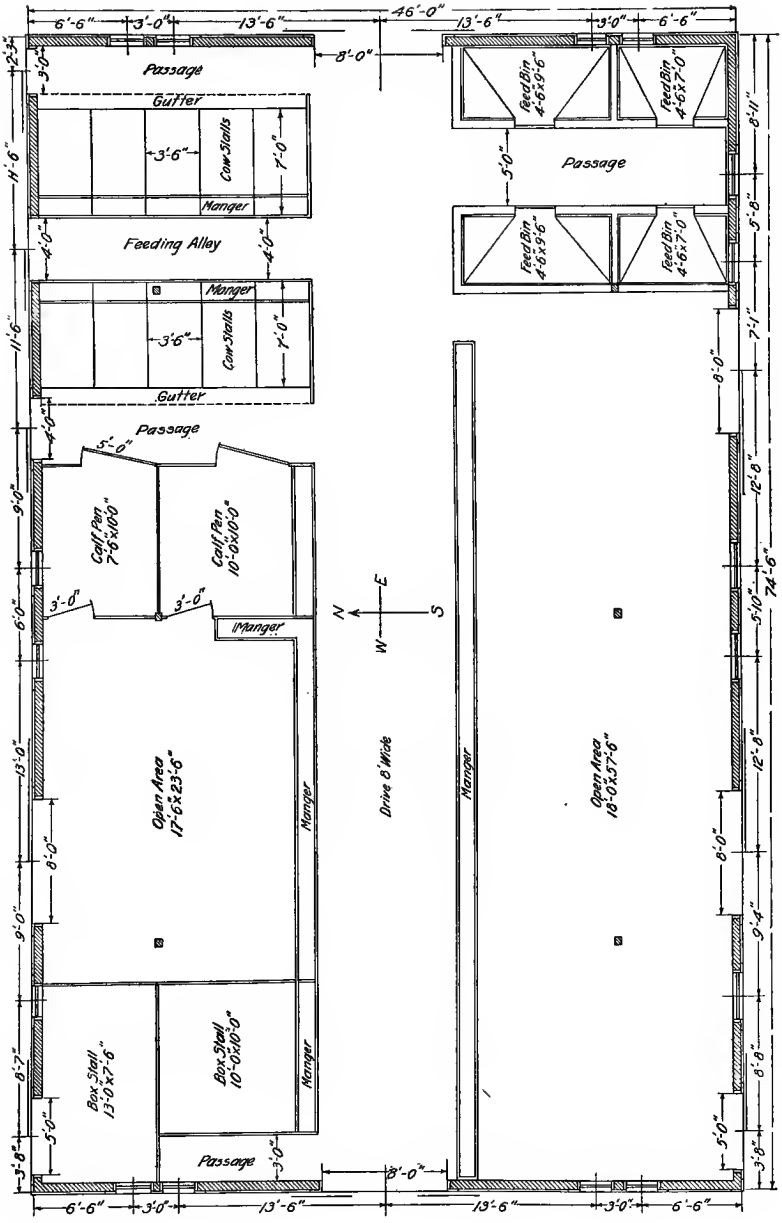

46'-0"
6'-6"
3'-0"
13'-6"
Passage
8'-0"
Gutter
Cow Stalls
3'-6"
7'-0"
Manger
Feeding Alley
4'-0"
Feed Bin 4'-6"x9'-6"
Feed Bin 4'-6"x7'-0"
5'-0"
Calf Pen 7'-6"x10'-0"
Calf Pen 10'-0"x10'-0"
Open Area 17'-6"x23'-6"
Drive 8' Wide
Open Area 13'-0"x57'-6"
Box Stall 13'-0"x7'-6"
Box Stall 10'-0"x10'-0"
N
S
E
W

FIG. 4

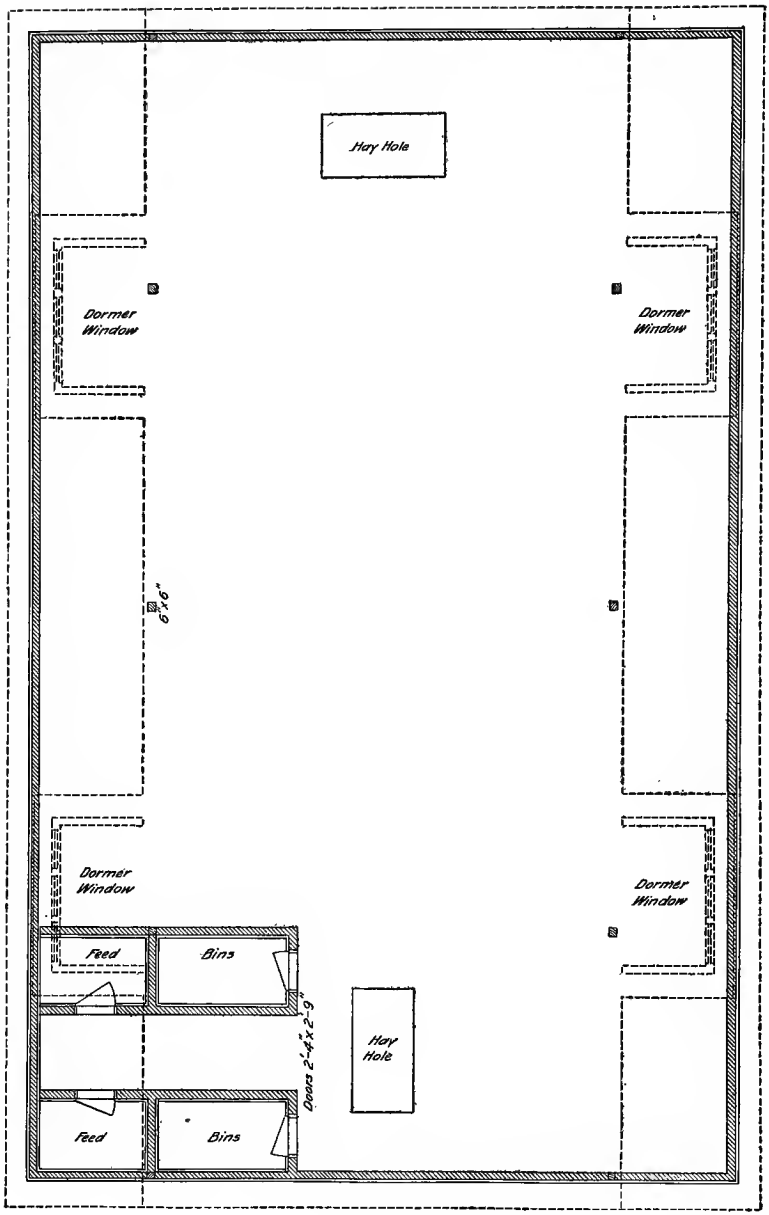

Hay Hole
Dormer Window
Dormer Window
6"x6"
Dormer Window
Dormer Window
Feed
Bins
Hay Hole
Door 2'-4"x 2'-9"
Feed
Bins

FIG. 5

3 inches to the plate, and 35 feet 3 inches to the ridge. The concrete foundation on which the barn rests extends 2 feet above ground, making the total height of the structure 37 feet 3 inches. The roof is of the gambrel type, by which construction a larger and more unobstructed mow is secured than would be possible with an ordinary gable roof. Two dormer windows on each side of the roof make the mow floor well lighted.

Fig. 4 is a ground plan of the barn with details pertaining to the interior arrangement, dimensions, etc. A central drive-

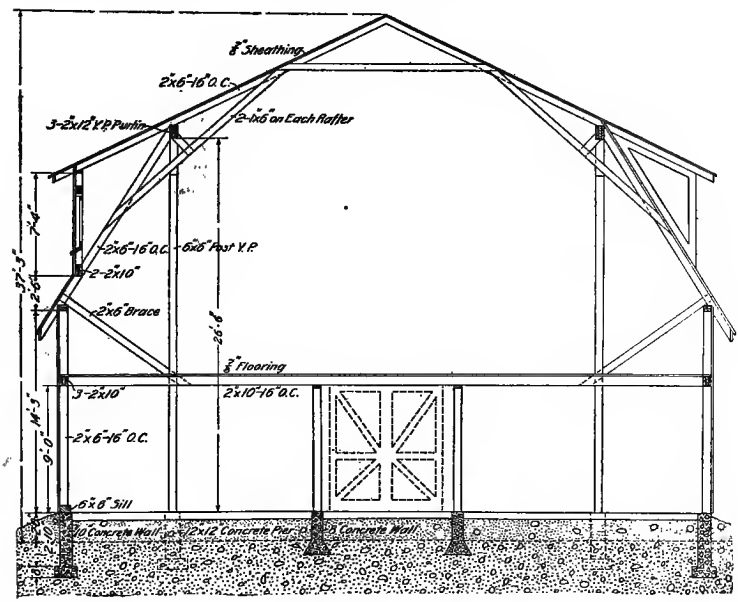


FIG. 6

way extends through the barn east and west. On the north side of the drive are stalls for ten cows, two calf pens, two box stalls, and an open area 20 ft. × 24 ft. in which animals may be turned loose. For a dual-purpose herd it may be found advisable to utilize all of this space for cow stalls. South of the drive are bins for feed and a large open area. The latter is suitable for use as an enclosed feed yard for cattle that are being fattened. An enclosure of this size will accommodate from thirty to forty

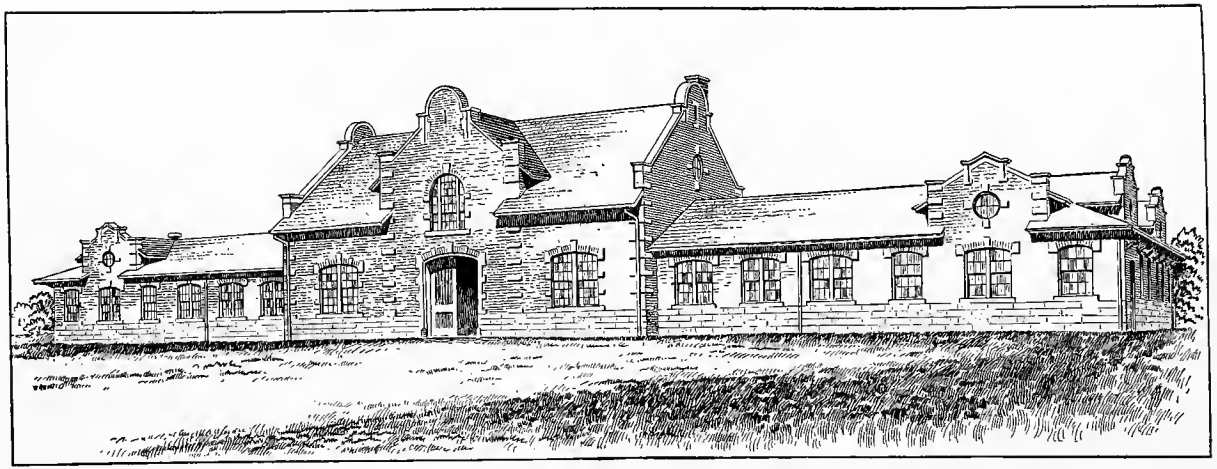
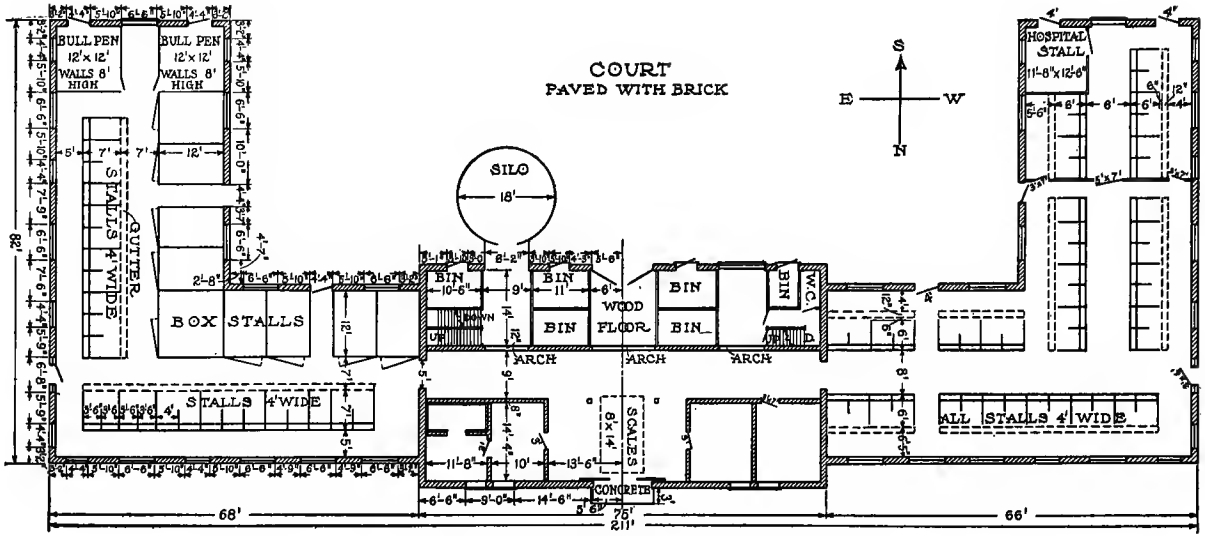


FIG. 7



FLOOR PLAN BEEF CATTLE BARN

FIG. 8

animals, depending on their age and weight. This enclosure opens to the exterior through three sliding doors shown in the

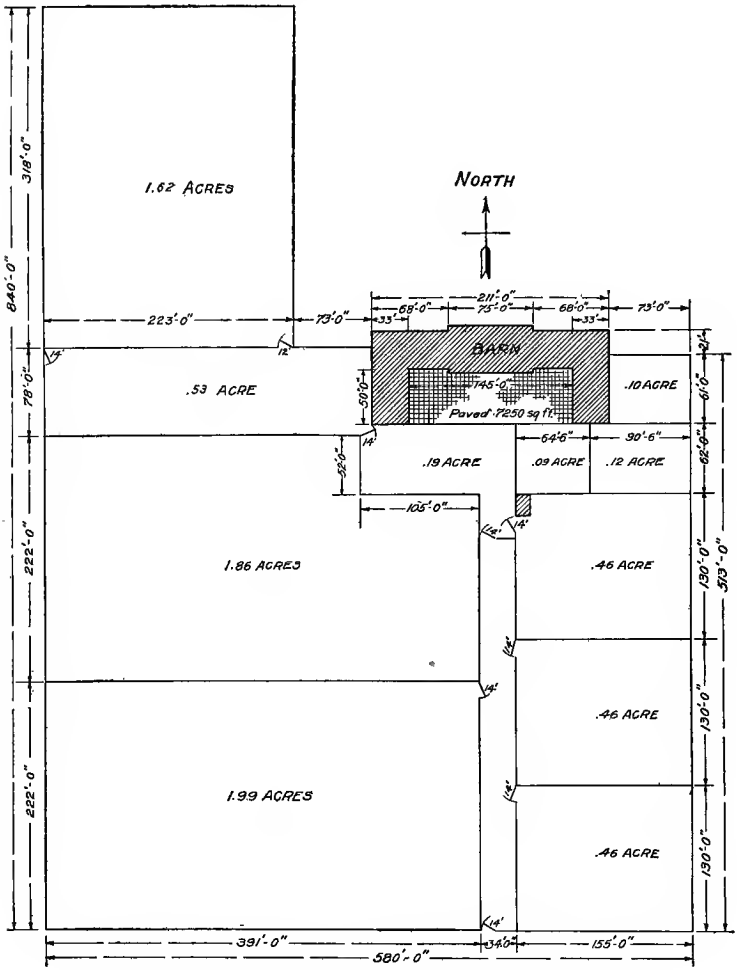


FIG. 9

plan. This arrangement is especially convenient in case it is desired to separate the fattening cattle into two or three groups,

for it is then only necessary to place a partition fence or wall across the enclosed area between two doors.

The mow floor plan is shown in Fig. 5. The feed bins on this floor communicate with those shown in the first-floor plan. The absence of upright timber through the middle of the mow is a point that should be particularly noted, for this arrangement greatly facilitates the handling of hay in the mow.

Details of the gambrel roof and other essentials of the construction are shown in Fig. 6, which is a cross-section through the structure and will furnish data from which almost any builder can erect a similar structure.

9. Elaborate Beef-Cattle Barn.—In Fig. 7 is shown a general view of an elaborate and commodious beef-cattle barn that is in use at the University of Illinois. It is unlikely that an individual farmer will build such a barn as this, but a study of its arrangement and design is likely to afford useful suggestions that may be utilized in less elaborate structures, hence some detailed views are shown. Fig. 8 is a floor plan of the barn showing general dimensions, details of the interior, location of silo, and other points of interest. The barn will accommodate one hundred head of cattle. The walls are of hard paving brick, the roof is of slate, and the floors are concrete except where indicated. The partitions and stalls in the interior are in iron frames, which keep all timber and boards up out of the litter and dampness and add greatly to the sanitary possibilities of the building as well as to its durability. In Fig. 9 is shown a plan of the lots adjoining the barn, together with the area enclosed in each lot and lanes or alleyways giving access to them. The plan is one that furnishes a number of lots of various sizes easily accessible to the barn, and with slight modifications can be adapted to other barns than the one shown.

10. Barn and Paddock for a Bull.—Not infrequently a cattle owner finds it advisable to construct a small barn or shelter for the exclusive use of a herd bull. In such cases it is important that a paddock in which the animal may have his freedom for exercise be provided adjacent to the barn.

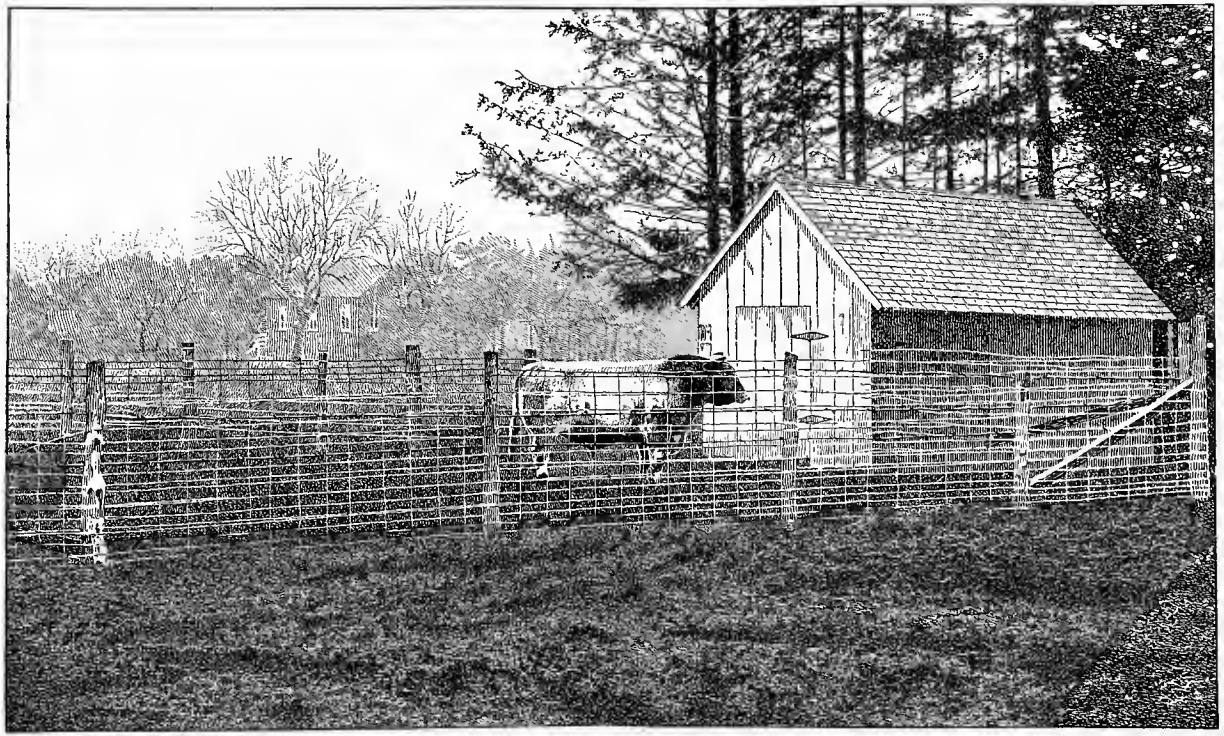


FIG. 10

One of the most important requisites of this equipment is to make it strong enough to resist any efforts that a vicious animal may make in an endeavor to break out of it. Needless to say, there is an almost endless variety of plans by which a bull-proof barn and paddock may be provided. In Fig. 10 is shown a small barn and exercise lot that one beef-cattle raiser has found satisfactory. The barn is strongly built of 2-inch lumber and contains no fixtures other than a manger. The fence consists of a woven wire on the outside of the posts and barbed wire on the inside. There is, of course, some objection to the use of barbed wire and many farmers will prefer to omit it and use only woven wire or to build an iron fence or one of hardwood plank. If woven wire is used it should be the strongest obtainable and closely woven. If it is desired to construct a fence similar to the one shown in Fig. 10, the barbed wires should be spaced about 4 inches apart up to $3\frac{1}{2}$ feet from the ground and then the distance between the wires may be increased gradually as follows: 8 inches, 10 inches, and 12 inches. The total height of the fence should be 6 feet.

SHEDS

11. Combined Shed and Storage Barn.—In Fig. 11 is shown an illustration of a very satisfactory open shed and feed storage building suitable for fattening cattle or for beef-breeding cattle. The shelter consists of a main building 20 ft. × 20 ft., with 20-foot posts, and two wings each 20 ft. × 30 ft. This makes a shelter 20 ft. × 80 ft. The upper floor of the main building is used for the storage of feed, which is fed out into the bunks below. A bin 10 ft. × 20 ft. is located on the lower floor of the main building and is used for the storage of corn. A paved lot adjoining the shed is 24 ft. × 80 ft., the bricks being laid flat on 6 inches of gravel, the latter being packed by the tramping of horses until a solid surface was secured. Cement was applied after the bricks were laid. The curbing consists of curbstones 18 inches wide and 3 inches thick set edgewise into the ground. Adjoining the paved lot is a yard containing about $\frac{1}{2}$ acre in which the hay rack is located

and where the cattle are allowed to remain a large part of the time. The yards and shelter are designed to accommodate about fifty cattle.

12. Shed and Feed Lots at the Missouri Experiment Station.—A general view of a shed and feed lot used at the Missouri Experiment Station for enclosing beef cattle is shown in Fig. 12. The shed is 300 feet long and 30 feet wide; the height to the eaves is 10 feet and to the ridge is 19 feet. It faces the

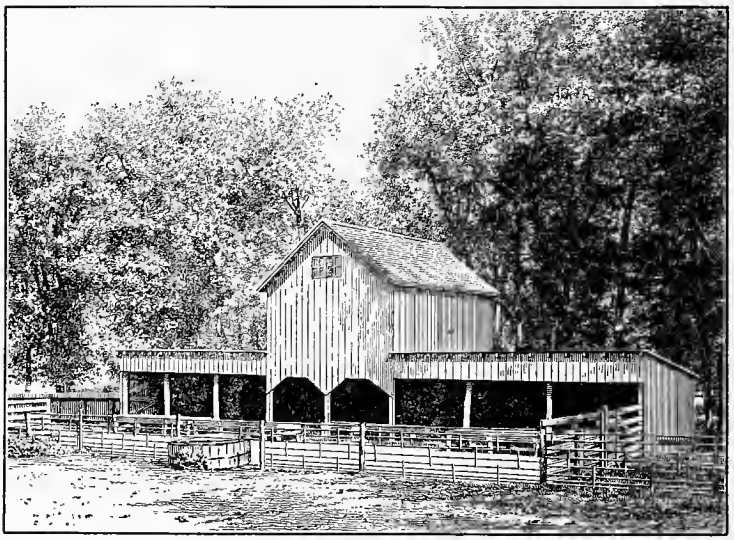


FIG. 11

south and is open on this side, as will be seen in the illustration. A loft above the cattle compartment and extending the entire length of the building provides for the storage of feed.

The general ground plan of the west end of the shed and the arrangement of the feed lots are clearly shown in Fig. 13. A feeding alley 5 feet wide extends along the entire length of the north side of the shed. The remainder of the shed is divided into fifteen compartments, or pens, five of which are shown in Fig. 13. Each of these pens is continuous with an open feed lot, as indicated in the plan. Dimensions of all of these

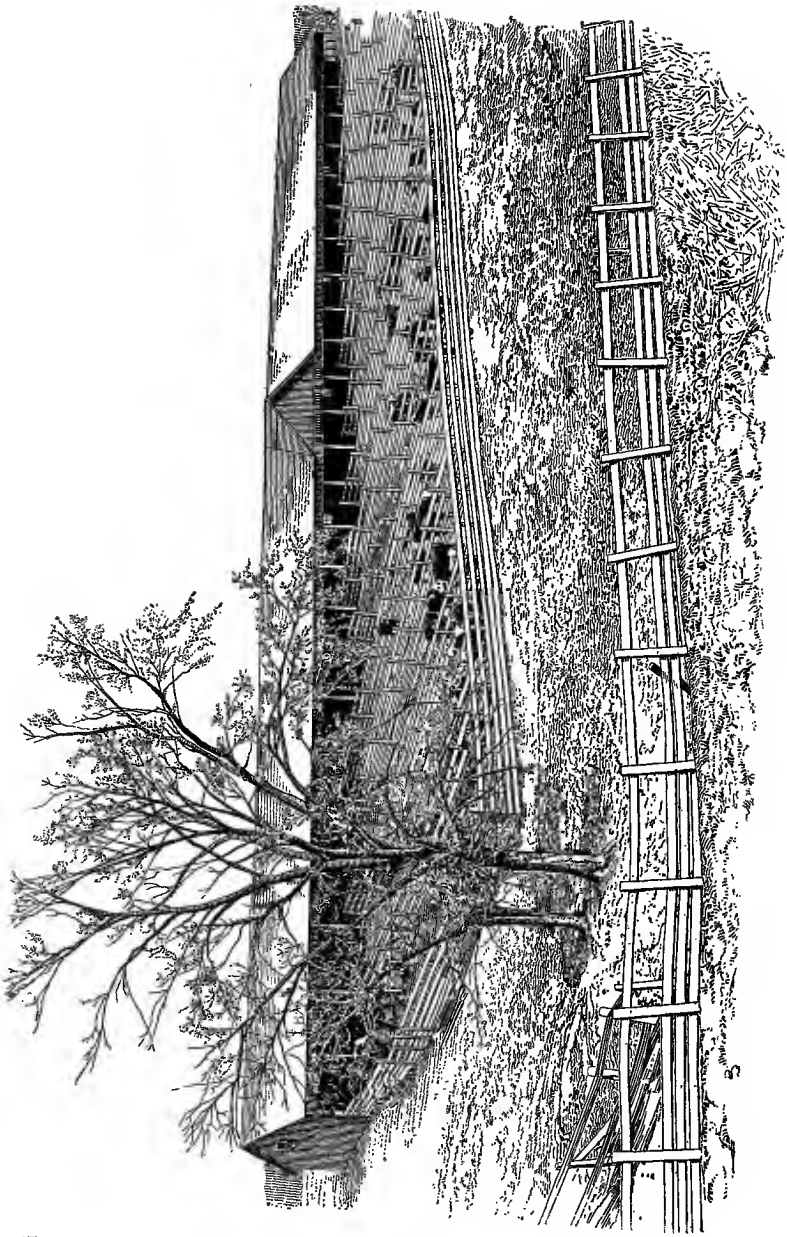


FIG. 12

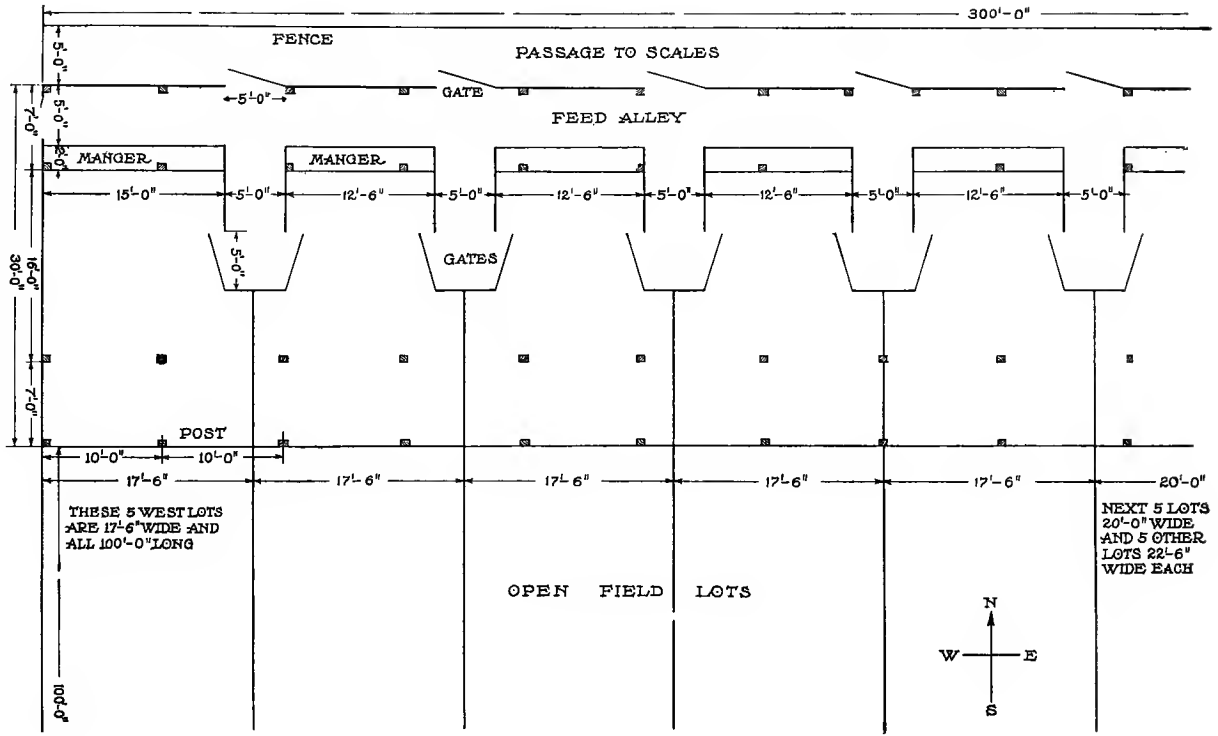

300'-0"
FENCE
PASSAGE TO SCALES
5'-0"
5'-0"
5'-0"
GATE
FEED ALLEY
7'-0"
MANGER
MANGER
2'-0"
15'-0"
5'-0"
12'-6"
5'-0"
12'-6"
5'-0"
12'-6"
5'-0"
12'-6"
5'-0"
5'-0"
GATES
30'-0"
16'-0"
7'-0"
POST
10'-0"
10'-0"
17'-6"
17'-6"
17'-6"
17'-6"
17'-6"
20'-0"
THESE 5 WEST LOTS ARE 17'-6" WIDE AND ALL 100'-0" LONG
NEXT 5 LOTS 20'-0" WIDE AND 5 OTHER LOTS 22'-6" WIDE EACH
OPEN FIELD LOTS
100'-0"
N
W
E
S

FIG. 13

details are shown in the diagram. It should be noted that the five pens in the west end of the shed are 17 feet 6 inches wide. The next five pens are 20 feet wide, and the five at the east end of the shed are 22 feet 6 inches wide. By making the pens of different sizes, accommodation is provided for small, medium, and large animals; and in case it is desired to place stalls in the pens, groups of stalls of different sizes can be worked into the various pens to better advantage than would be possible if they were all of the same size. Outside of the shed along the north side is a passage or lane through which the cattle are taken to and from the scales.

The approximate cost of this equipment is given by the builders as $2,275, apportioned as follows: Shed, $1,800; fencing, $200; water supply, $125; grading, $100; and painting, $50. A smaller establishment along the same general lines would doubtless meet the requirements of most individual feeders. In some cases the outlay for water supply and for grading may be unnecessary and a corresponding saving in cost may be effected.

13. Shed and Feed Lots at the Illinois Experiment Station.—A general plan for a convenient arrangement of sheds and feed lots is illustrated in Figs. 14 and 15. The quarters here shown are those in use at the Illinois Experiment Station and are large enough to accommodate 250 head of beef cattle. While it is not likely that an individual feeder would have occasion to install a duplicate of this equipment, there are, nevertheless, numerous features of it that are adapted to ordinary requirements and that may easily be worked into a modified plan. Fig. 14 is a general view of the establishment and Fig. 15 is a ground plan, from which it will be seen that the equipment comprises a barn 44 ft. × 72 ft., with a silo attached, and twelve feed lots adjacent to an alley that leads to the west side of the barn. South of the feed lots is a corn crib 8 ft. × 144 ft. The lots on the south side of the alley are each 48 feet long by 36 feet wide, exclusive of the shed, which is 12 ft. × 36 ft. and open to the south. Each of these lots is enclosed by a board fence 4 feet 8 inches high, and is paved with

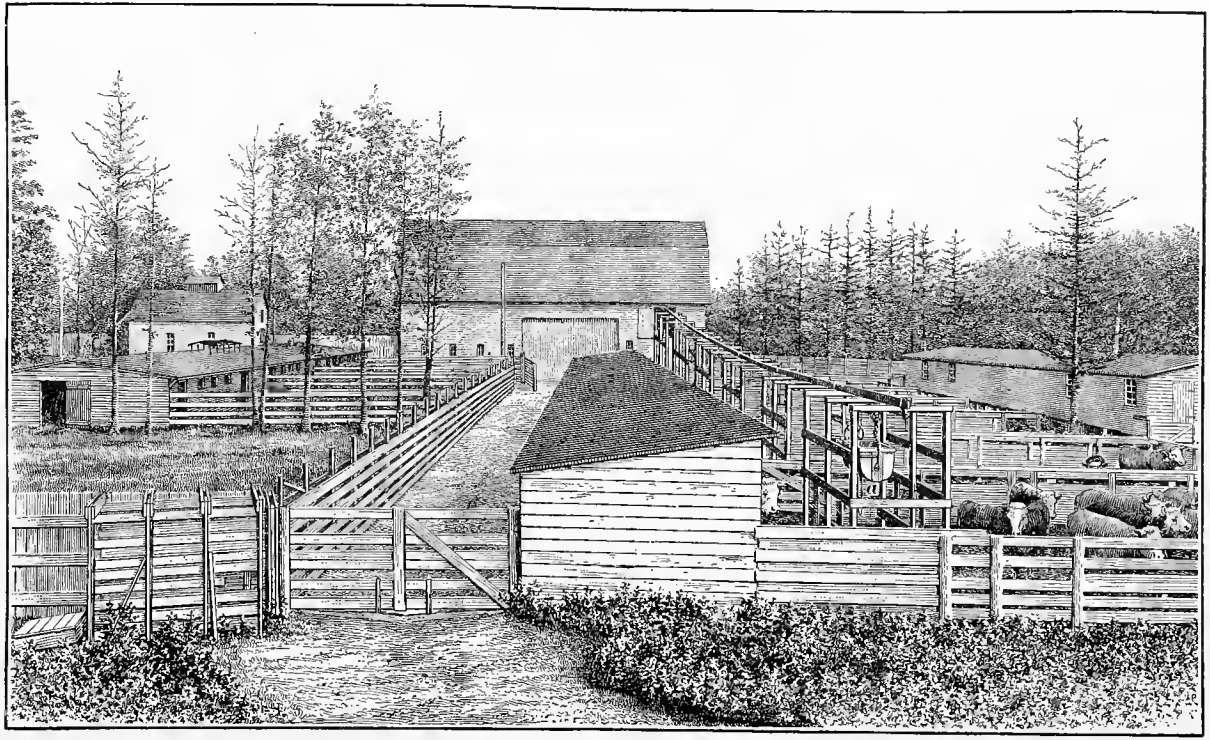


FIG. 14

brick laid flat, but the sheds are not paved. These lots have gates leading into each other, to the alley, and out of the south end of the lots. North of the alley are five feed lots, four of which are 36 ft. × 36 ft., and one is 58 ft. × 108 ft. Two of these lots are paved with brick and the others are unpaved. The shed is 24 ft. × 144 ft., fully enclosed, but sliding doors give access to each of the five feed lots adjoining it. This shed was originally built to house breeding stock in winter. The south side is 6 feet high to the eaves, the north side is 5 feet 6 inches high, and the ridge is 8 feet high. Split-oak

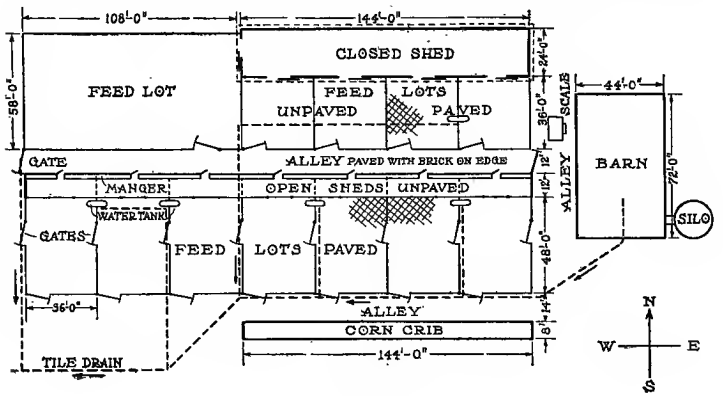


FIG. 15

posts for the siding are set in the ground every 6 feet, and 4″×4″ posts 10 feet long are set 2 feet in the ground and 12 feet apart through the middle of the shed for supporting 2″×12″ plates.

The shed south of the alley is 252 feet long and 12 feet wide, and is divided into seven equal compartments by the extension of the fences that separate the corresponding feed lots. The sides and roof of this shed are supported on the north side by split-oak posts set in the ground 6 feet apart and on the south side by 4″×4″ posts set 12 feet apart. The plates are 2 in. × 6 in., 3 feet on center. The shed is sided with 8-inch shiplap. The north side of the shed, which faces the paved alley, is 6 feet high, and the south side is 8 feet high, thus giving the roof a slope of 2 feet. The boards of the roof

project over the frame work 1 foot 5 inches on the side toward the lots and 7 inches on the side toward the alley. The shed is roofed with 1-inch lumber, over which is fastened prepared roofing.

Except for the space taken up by doors opening into the alley back of the sheds, a manger in which roughages are fed runs the entire length of the shed. The concentrates are fed in portable troughs set in the open lot. At *a*, in Fig. 14, is seen a feed carrier for transporting feed from the barn to the feed lots, also the framework for supporting the overhead track on which the carrier runs.

The alley between the two groups of feed lots is 12 feet wide, and is paved with brick set on edge, the paving extending from the barn to the gate. A dip of $4\frac{1}{2}$ inches from the edge to the center of the pavement and a fall of $3\frac{3}{4}$ feet from the barn to end of the alley, where the drain is located, keeps the alley dry and also serves the purpose of draining the water flowing from the roof of the sheds situated south of the alley. Experience has shown that the $4\frac{1}{2}$-inch incline from the edge to the center of the alley is too steep, and that 2 inches would be ample.

14. In paving the feed lots, they were first graded so as to bring them somewhat above the surrounding level. An incline of $6\frac{1}{2}$ inches was given to each lot from north to south and $3\frac{1}{4}$ inches from east to west. By this arrangement water falling on the lots runs to the southwest corner, where a drain is provided to carry surplus water away. Here again it was found that rather more incline was given to the surface than was required.

After the desired grade had been secured the ground was covered with 6 inches of gravel, which was rolled and tamped down solid, covered with 1 inch of fine sand on which No. 1 paving brick were laid flat as indicated in Fig. 16 (*a*), except in the alley and around the scales, where they were placed on edge. After being put in place, the brick were rolled down even and if upon inspection any were found to be soft they were replaced with good ones. The space between the brick was

filled with a grout filler consisting of 1 part clean, sharp sand and 1 part of Portland cement. The cement and sand were thoroughly mixed dry in tight boxes, then made into a mortar of the consistency of cream and thoroughly broomed into the joints. The slushing was repeated to insure the filling of all cracks or joints between the bricks. This was done to keep water from getting underneath the pavement.

The work was done in summer and the cement filler was allowed to set a week before heavy loads were permitted on

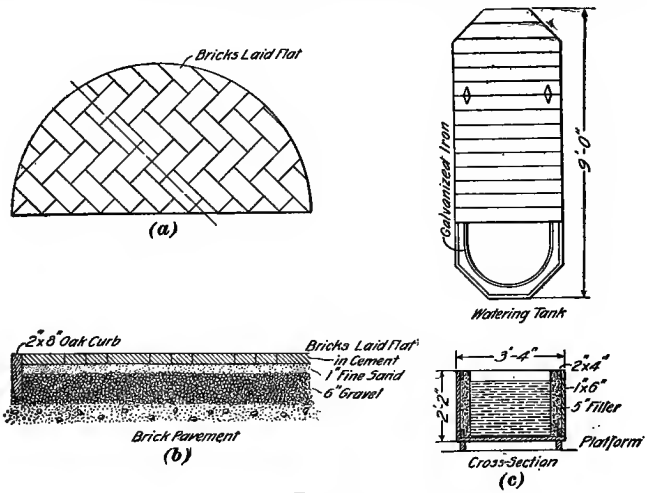


FIG. 16

it and the sun's rays were kept off by means of a canvas for the first day. A retaining curb of 2″×8″ plank, braced by a 4″×4″ piece, placed 2½ feet in the ground was put in at the gates to keep the animals from breaking the edge of the brick. Next to the shed, 2″×8″ oak plank were used for curbing, as shown in Fig. 16 (*b*). Where there are fences, the bottom board was placed low enough to act as a curb. Experience has shown that it is best to make all curbs of concrete.

15. Five galvanized iron tanks 2 ft. × 2 ft. × 8 ft. are so placed that the steers in two lots have access to one tank. These tanks are supplied with water by means of hydrants at the end of pipe lines connecting the lots with the storage

tank. A pipe extends from a tap at the bottom nearly to the top of the tank to let the water flow into the drain in case it is left turned on too long, and when a tank is to be cleaned this pipe is unscrewed and the water allowed to drain from the tank. The tank is set in a wooden box the size of which leaves a space of 5 inches between it and the tank, in which may be placed a filler to keep the water from freezing. This construction is illustrated in Fig. 16 (*c*). The box and tank rest on a platform raised 6 inches from the pavement. Material for boxing is 1″×6″ lumber matched, nailed to 2″×4″ pieces. The ends of the 2″×4″ pieces are bolted and braced by a 1″×½″ iron strap. This was found necessary in order to keep the cattle from crushing in the ends of the box. A lid on

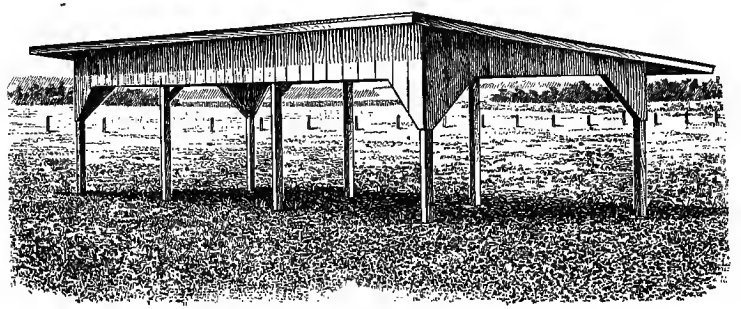


FIG. 17

hinges at each end of the tank can be closed down in cold weather to prevent the water from freezing or to prevent the cattle from drinking at weighing time.

16. Open Shed for Shade.—Beef or dual-purpose cattle cannot be successfully maintained without ample shade during hot weather, and if natural shade is not available it is sometimes necessary to erect a shed in a pasture or feed lot for the purpose of providing shade for the cattle. Fig. 17 shows how, in the absence of trees, shade may be provided in a pasture. The shed shown is 12 ft. × 36 ft. and furnishes ample summer shelter for ten mature cattle. The posts are of sawed oak set in concrete. The roof is covered with a good grade of prepared roofing.

FEED BUNKS AND MISCELLANEOUS EQUIPMENT

17. Ten-Sided Feed Bunk.—In Fig. 18 is shown a ten-sided feed bunk that is satisfactory if the cattle that are to be fed from it are dehorned; cattle with horns are likely to

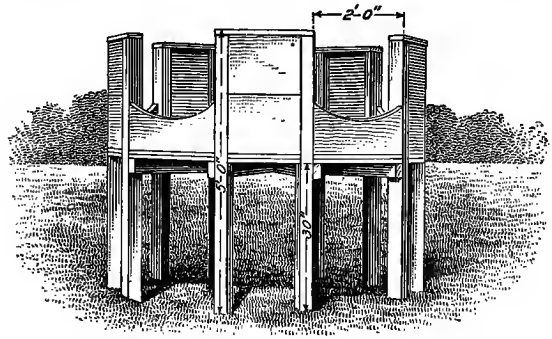


FIG. 18

get caught and injure themselves on the rack. The dimensions of the rack are indicated in the illustration, from which it will be seen that the bottom of the feed box is 30 inches from the ground. For small animals, it may be advisable to reduce this distance to 24 inches, and in the case of large animals 36 inches may be a better height.

18. Rectangular Feed Bunks.—A dimensioned drawing of a rectangular feed bunk 12 feet long is shown in Fig. 19. The

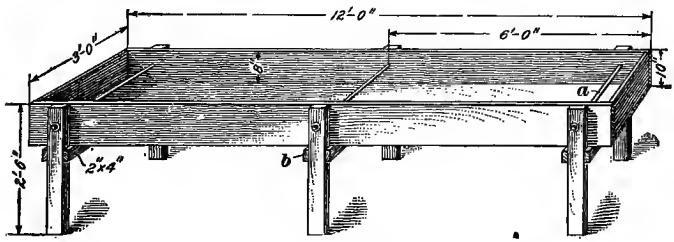


FIG. 19

feed box is 10 inches deep and is set on six legs of 3″×4″ oak 2 feet 6 inches high. Three ½-inch iron rods *a*, and six 2″×4″

cross-bars *b* serve as braces. The bottom and side of the feed box are of yellow pine.

Fig. 20 illustrates a 16-foot rectangular feed bunk such as is commonly seen in beef-cattle feed lots, and Fig. 21 shows a

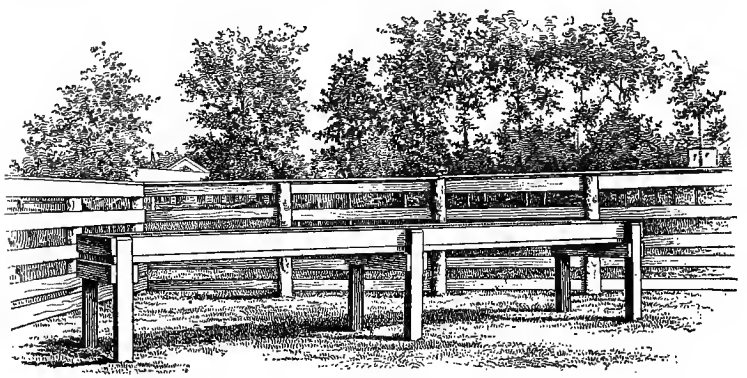


FIG. 20

detailed view that will enable any workman to construct such a bunk. The inside dimensions are: length, 15 feet 8 inches; width, 2 feet 8 inches; and depth, 6 inches. The floor of the feed box consists of six 2″×6″ planks 16 feet long. The sides are 2″×6″ planks 15 feet 8 inches long and the ends are of the

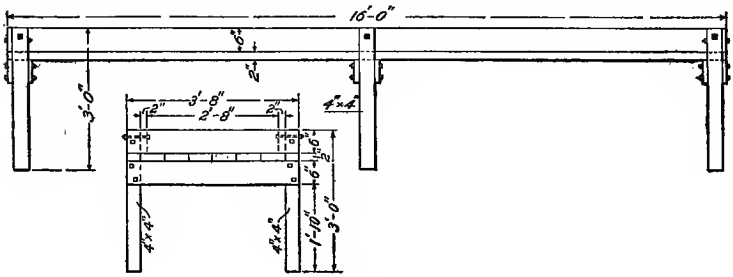


FIG. 21

same material and 3 feet long. The bunk is supported on six 4″×4″ posts 3 feet long, and each pair of posts is braced by two 2″×6″ crosspieces 3 feet 8 inches long. As shown in the detailed view, bolts are used for putting the bunk together.

19. Feed Bunk for a Muddy Lot.—It is in all cases desirable to have feed lots so arranged that they will always be dry and clean, but it sometimes happens that for one reason or another cattle must be turned into a muddy lot. In such cases a feed bunk with a platform is a desirable adjunct to the equipment. A general view of a feed bunk on a platform is shown in Fig. 22, and detailed views giving dimensions are

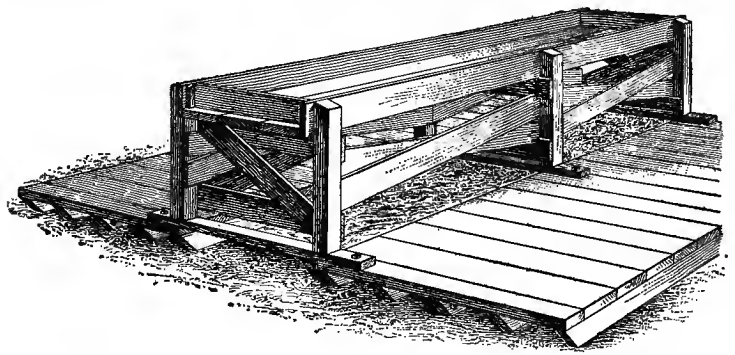


FIG. 22

shown in Figs. 23 and 24. The platform on each side of the bunk is made by placing on edge five 2″×4″ white-oak scantling 16 feet long and laying on them a floor of 2-inch planks

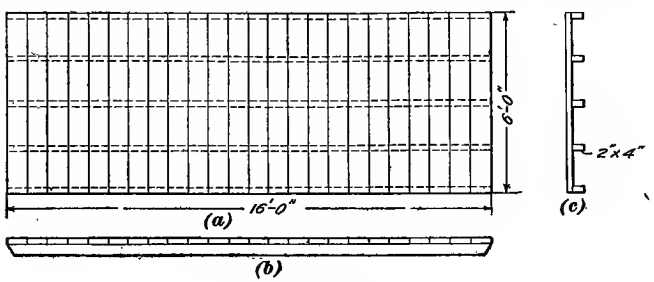


FIG. 23

6 feet long, making a floor 6 feet wide and 16 feet long. The scantlings are beveled at each end like sled runners, and a hole is bored in the end of the middle scantling of each platform for a clevis so that the floor can be dragged from one place to another. This construction is illustrated in Fig. 23,

in which (*a*) is a plan view, (*b*) a side view, and (*c*) an end view of one of the platforms.

The bunk should be constructed of oak, as it is durable and the cheapest in the end. The bed, or box, should be made of 2″×6″ stuff, the side and bottom pieces 16 feet long and the end pieces 3 feet long. The end pieces are set 2 inches inside of the ends of the side and bottom pieces, making a box the inside dimensions of which are 3 ft. × 15 ft. 4 in., and 4 inches deep. The six posts should be 4″×4″ pieces 2 feet 6 inches long and beveled off at the top so as to shed water and so that there may be no sharp corners to injure the cattle. The crossties under the feed box should be 1″×6″ pieces and long enough to reach across.

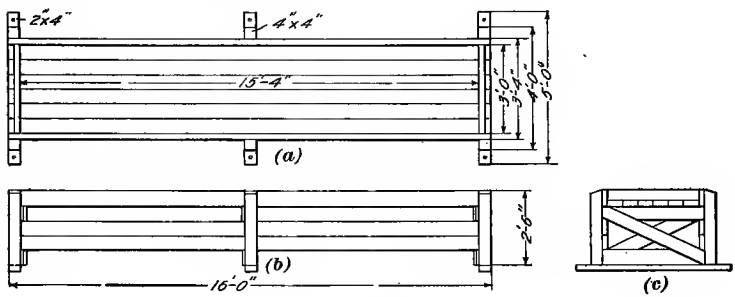


FIG. 24

After the bunk is made it should be inverted and 2″×4″ strips 5 feet long nailed crosswise to the bottom of the posts. This length will allow the strips to project 6 inches past the post on each side, as shown in the illustration. The two platforms should then be placed in position about 3 feet apart, and the bunk set on them. The bunk is secured to the platforms by boring a hole through the crosspieces on the bottom of the posts and through the floor, and dropping in bolts.

Three bunks of the dimensions given will be enough to accommodate from forty-eight to fifty head of cattle. The bunks should be arranged in a row, as this is a great convenience in feeding, and when the bunks are so arranged there is less tendency for the cattle to go from one bunk to another than if some other arrangement were made. The platforms

keep the feeder and the cattle out of the mud, and all droppings and waste feed fall upon them. This gives the hogs a chance to get at the waste feed before it is lost in the mud.

20. Fences.—It is important that fences about feed lots, pastures, and paddocks in which beef and dual-purpose cattle are enclosed be strong and rigid. A fence of barbed wire is probably most commonly used and the least expensive. To be satisfactory, a fence of this kind should be at least 5 feet high and consist of from six to eight strands of wire strung on strong posts set not more than 10 feet apart and 2 to 3 feet in the ground. Woven wire is extensively used and is superior to barbed wire in appearance, durability, and safety.

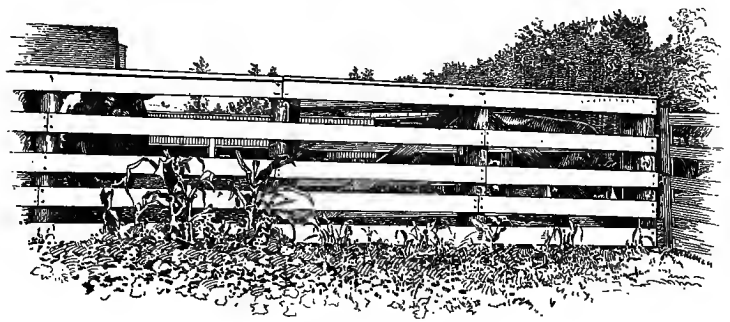


FIG. 25

When fences are subject to constant strain, as around barns and where cattle run on both sides, woven wire is not very satisfactory, since the cross-wires soon get out of place or broken. In such exposed positions, it is frequently found advisable to construct a plank fence such as is shown in Fig. 25. This fence is built of 2-inch planks 6 inches wide spiked to posts set 8 feet apart and 3 feet in the ground. The three lower planks are set 4 inches apart; the fourth plank is set 6 inches above the third; and the fifth, or top, plank is set 8 inches above the fourth. The total height of the fence is 52 inches or 54 inches in case a cap board is used to finish the top as shown in the illustration.

In localities where timber is plentiful, use is sometimes made of what is known as a pole fence such as is illustrated in Fig. 26.

The method of construction is evident from the illustration. The usual plan is to set the upright posts *a* deep enough in the ground to give them considerable rigidity and set the inclined supports *b* just deep enough to prevent them from being easily displaced. The poles *c* are usually cut in 12-, 14-, or 16-foot lengths and at the ends are fastened to the posts by wire, or if the poles are of small diameter by means of heavy spikes.

21. Pinch Gate.—The device known as a pinch gate is really a sort of adjustable stall in which an animal can be closely confined. It affords a convenient means for securing cattle during castrating, dehorning, branding, treating wounds,

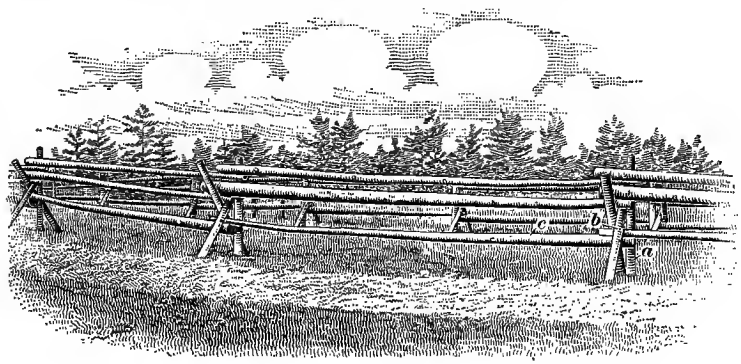


FIG. 26

and on other occasions when it is necessary to get hands on an animal. In the construction of the pinch gate described here, three strong posts are required. Two of these posts, marked *a* and *b*, are placed at the front of the pinch gate and the third post *c* is placed at the rear end of the gate, this arrangement being illustrated in Fig 27, which is a top view of the finished pinch gate. These posts will often be subjected to severe strains when the gate is in use, and it is recommended that they be firmly anchored by setting them in concrete. Each of the front posts has hung to it a 12-foot gate and to the rear post is hung a gate 2 feet 6 inches long. The manner in which these gates are adjusted to form an enclosed space for

confining an animal is shown in Fig. 27, in which *d* is the right-hand gate, *e* is the left-hand gate, and *f* is the short, rear gate. If the pinch gate is built in connection with an alley, as is usually the case, the alley should be narrow enough to be closed by one of the 12-foot gates when it is swung open.

The right-hand gate and the rear gate can be brought together at the right-hand rear corner of the enclosure, at which point there is no post, but the two gates can be fastened together by means of a bar on the rear gate that passes through a hasp on the right-hand gate and is fastened with a key. The left-hand gate swings clear of the rear post, but may be fastened to it if desired by means of a slip bar in the gate. If it is desired to still further confine an animal, the left-hand gate may be swung in and secured at the desired point by means of notches *g*

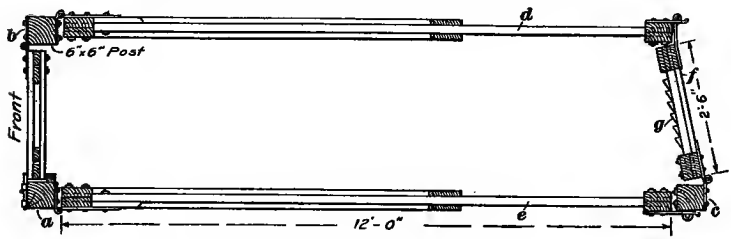


FIG. 27

on the rear gate. A piece of strap iron ½ inch thick and 3 inches wide is so bent as to form these notches and attached securely to the middle plank of the rear gate.

Since the gates, like the posts, are likely to be subjected to severe strains, it is advisable to construct them largely of 2″×6″ cypress or oak lumber, using bolts to fasten the pieces together. The 2″×6″ upright pieces at the ends of the gates should be mortised in such a manner as to fit one on each side of the horizontal planks. The middle upright will be strong enough if a piece of 1″×6″ material is used on each side of the gate without mortising. A brace of 1″×6″ material should be attached on each side of the gate extending from the bottom of the hinged end diagonally up to the top of the middle upright as shown in the illustration. The finished gate is

$4\frac{1}{2}$ feet high, measured on the uprights. The five horizontal planks are of $2'' \times 6''$ material, the spacing between the planks,

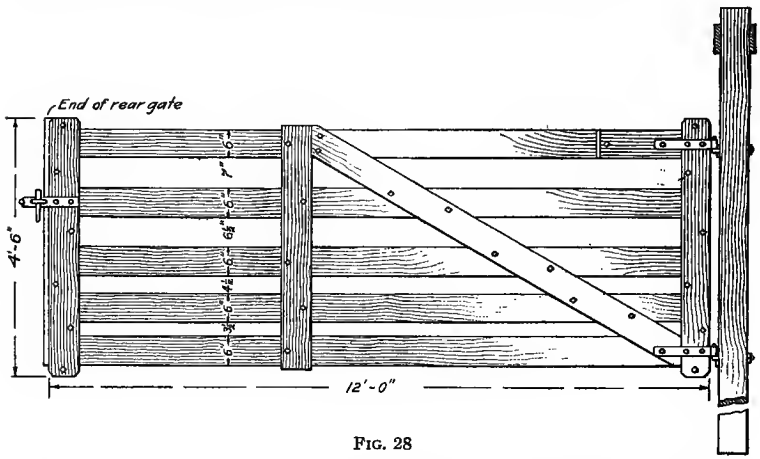


FIG. 28

beginning at the top, being 7, $6\frac{1}{2}$, $4\frac{1}{2}$, and $3\frac{1}{2}$ inches. This construction is illustrated in Fig. 28, which is a view from the right-hand side of the enclosure.

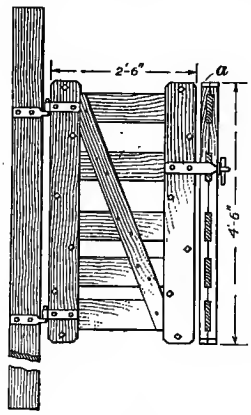


FIG. 29

In Fig. 29 at *a* is seen an end view of the right-hand gate, from which the method of mortising each $2'' \times 6''$ upright 1 inch deep to receive the horizontal planks will be evident. The left-hand gate is made like the right-hand gate, but it is provided with a slip bar of wood to secure it where desired on the rear gate.

The small gate, hung on the rear post, is made of the same material as the side gates. The dimensions and construction of the former are shown in Fig. 29.

A frame containing a stanchion is hinged to one of the front posts, as shown in Fig. 30. The stanchion is of the same material as the gates, except that the two upright pieces next to the posts of the pinch gate are of $3'' \times 4''$ material. About

2 inches from the top and 4 inches from the bottom of the uprights are crosspieces *a* of 2″×6″ material, one on each side of the uprights. A third pair of crosspieces *b* is placed so that their upper edges will be about 2 feet from the ground. The uprights, which are 4 inches thick, are mortised 1 inch deep on each side for the 2″×6″ crosspieces, leaving a 2-inch space for the pieces *c* and *d* that are used to secure an animal's head. The piece *c* of the stanchion is of 2″×6″ material and is set in the frame and bolted 2 inches from the upright of the frame. The piece *d* of the stanchion is of the same material and has its lower end bolted by a single bolt to the middle crosspieces and the upper end free. The upper end is cut to fit against the upright of the frame, when open, to give a wider opening than would otherwise be possible to the stanchion. The pieces *c* and *d* of the stanchion are hewn out 2 inches deep a foot above the middle crosspiece to give more room for an animal's neck. Holes are bored through the upper crosspieces as shown so that a bolt may be used to close the stanchion as far as the neck of the animal will permit.

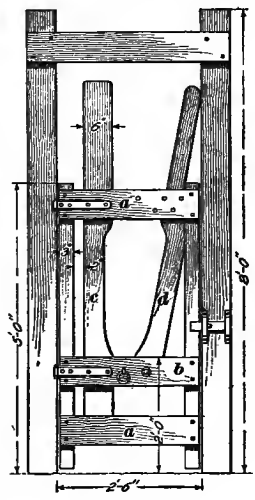


FIG. 30

If the stanchion is to be used for animals with wide horns, it may be desirable to set it in front of the posts instead of between them, as this will allow the end uprights to be placed farther apart and permit the stanchion to open wider. This would, of course, necessitate using longer crosspieces for the stanchion. In case the pinch gate is to be used in dehorning operations, it is well to place an iron ring on the middle crosspieces, as shown in Fig. 30, so that the animal's nose can be drawn down and secured during the operation.

A floor of rough concrete or planks with cleats on them should be provided, as the animals will soon tear up the dirt if no floor is placed under them.

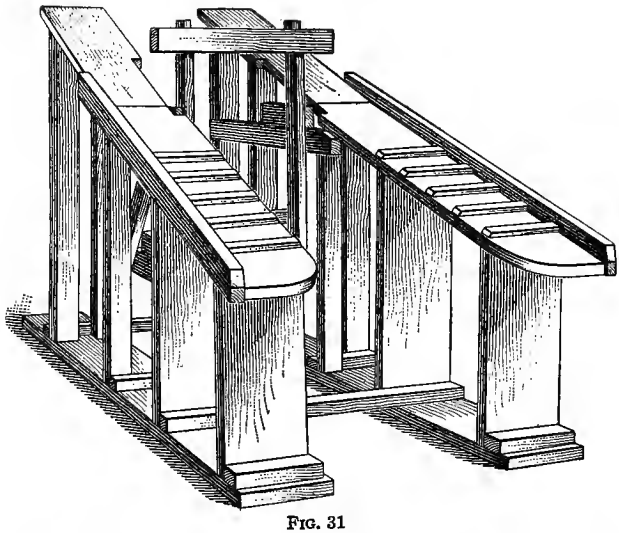
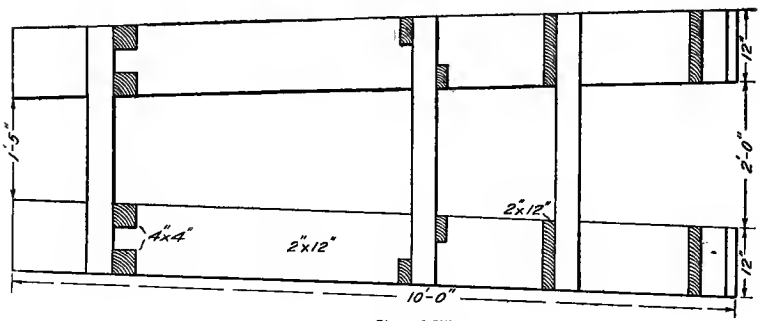
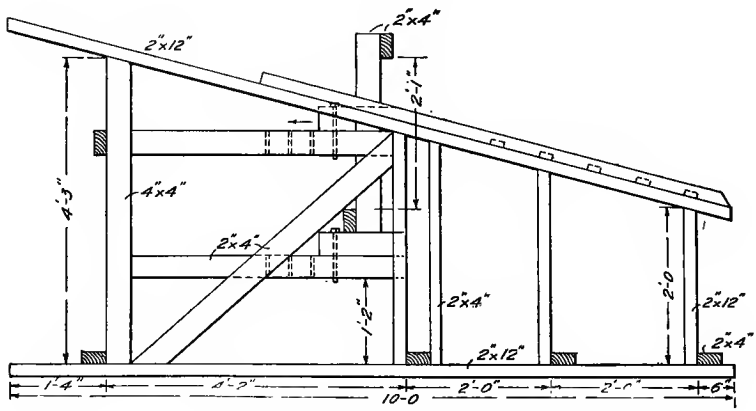


FIG. 31



Plan of Sill



Elevation

FIG. 32

22. Breeding Rack, or Crate.—Some cattlemen consider it advisable to make use of a breeding rack of some kind, particularly in cases when heavy bulls are employed for serving light heifers. Although it is true that such a device is not absolutely necessary and that probably the majority of cattle raisers do not make use of one, there are nevertheless cases in which it would be a valuable adjunct to the equipment of an up-to-date establishment. A satisfactory breeding crate is illustrated in Fig. 31, and a dimensioned drawing of the same crate is shown in Fig. 32. From these views any carpenter will

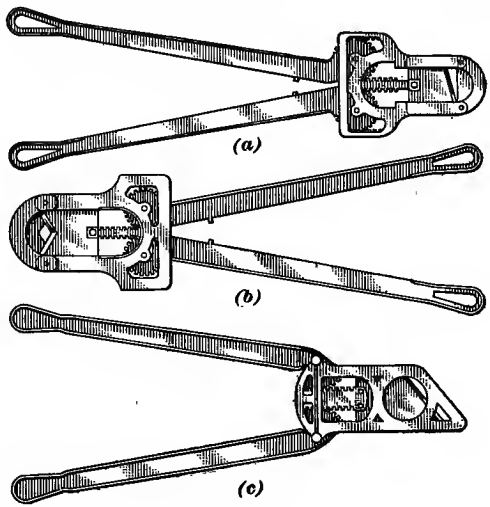


FIG. 33

have no difficulty in constructing one like it. A particularly desirable feature of this crate is the adjustable stanchion by means of which it can be used with small heifers or large cows. In Fig. 32 an arrow indicates the direction in which the stanchion may be moved forwards and dotted lines through the two horizontal pieces indicate holes through which a bolt may be dropped to secure the stanchion at any desired position.

23. Dehorning Shears.—In Fig. 33 are shown three of the principal types of dehorning shears used by cattlemen. In (*a*) is shown what is usually spoken of as the slant-blade

dehorner; in (*b*) is shown the **V**-blade dehorner; and in (*c*) is shown the Newton & McGee dehorner. All of these will do satisfactory work when the blades are kept in good condition.

In the operation of dehorning, the shears should be placed close to the base of the horn, so close, in fact, that when the horn is cut off a small rim of the skin and flesh at the base of the horn is taken with the horn. Experience has proved that by this method the wound will heal quickly and the horn will not grow subsequently; if the horn is cut in much outside of this point, it will continue to grow and make an unsightly stub.

Some calf dehorners are on the market with which calves may be successfully dehorned about the time the horns start. As a rule, however, young cattle are dehorned when they are about a year old, because up to that age the young cattle with horns will do no damage and at the age mentioned an animal is in better condition to recover quickly from the operation than is a young calf.

24. Bull Rings.—Bulls should be ringed before they are a year old, or, in other words, before they show any signs of becoming vicious. With the bull ring that is most commonly used it is necessary to make an opening through the tissue between the nostrils. This puncture can be made with a good sharp trocar or even with a pitchfork tine. Care should be taken to see that whatever tool is used for puncturing is thoroughly clean before it is used. A ring of the type known as a self-piercing bull ring, one of which is shown in Fig. 34, can be inserted without previously making a puncture. The ring is simply opened, placed in position in the bull's nose, and the points then brought together. A locking device is provided to prevent the ring from opening after it is once in position.

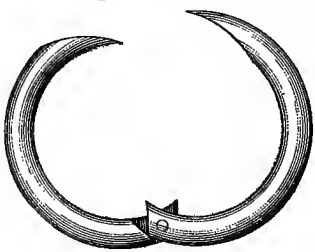


FIG. 34

25. Salt Boxes.—Salt boxes should be provided for cattle both in the pasture and in the feed lot. These boxes may be made 1 foot square or larger and 10 inches deep, and should

be placed under cover, if possible, where the cattle will have access to them, and at a convenient height. A good height is about 30 inches from the ground to the top of the box. In case the box is to be set out of doors in the pasture and unprotected, it should be made out of 2-inch planks and be 2 feet square and 1 foot deep. This will make it sufficiently heavy and strong as not to be easily upset or broken.

26. Dipping Tank.—A tank in which beef and dual-purpose cattle may be dipped for the destruction of skin parasites or for the treatment of skin diseases is often a valuable adjunct to the other equipment just described. This is particularly the case in the West and Southwest, where cattle scab or mange is a somewhat common disease, and also in the South where the so-called tick fever prevails. The essential features of a dipping equipment are a tank large enough to permit of submerging an animal, a chute with a smooth incline through

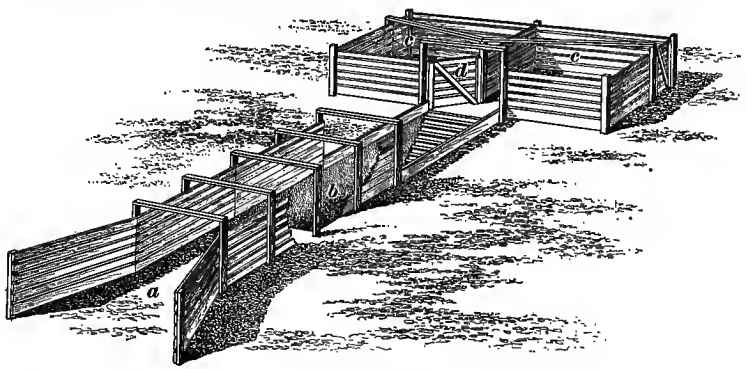


FIG. 35

which the animals may be sent into the tank, and a draining pen where the animals are kept for a short time after they emerge from the tank and where the solution that drips from them may be collected and returned to the dipping tank.

In Fig. 35 is illustrated a general plan of a cattle-dipping plant, in which the chute leading to the tank is shown at *a*, the tank at *b*, and two draining pens at *c*. In this case the gate *d* is so arranged that in one position it closes the right-hand pen and leaves a passage from the tank to the left-hand

pen; when the gate is swung to the other side a passage to the right-hand pen is opened and the left-hand pen is closed. In this way it is possible to hold one pen of animals while the other is being filled, then release the first lot and fill the pen again while those in the second pen are draining.

Dipping tanks are usually of steel, concrete, or wood. It is likely that in most cases a tank of concrete or steel will be found more economical and more satisfactory, in the end, than one of wood, on account of their greater durability and freedom from leakage, and the cost is only slightly greater than that of

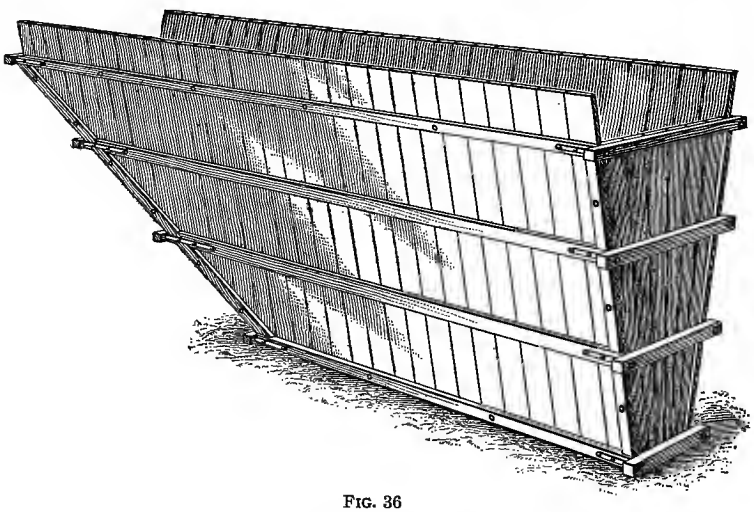


FIG. 36

wood. Steel dipping tanks can be purchased from most dealers who handle water tanks.

A concrete dipping tank can be constructed by making a form of lumber, the form being of the size and shape desired for the inside dimensions of the finished tank. This form is then placed in an excavation that is large enough to receive it and at the same time allow space enough at the ends, sides, and bottom for the concrete wall. A concrete mixture such as is recommended for barn foundations is satisfactory for dipping-tank construction. Some reenforcing material such as iron rods, woven wire or ordinary fence wire, should be embedded

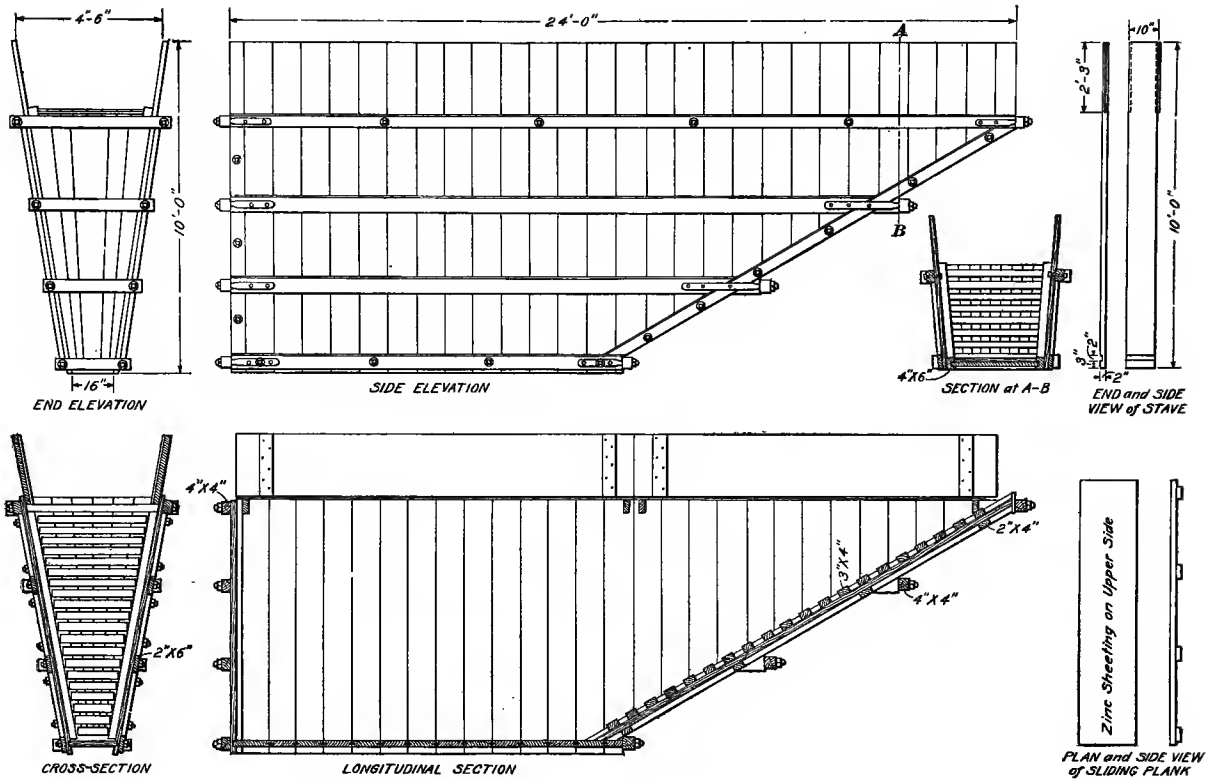

4'-6"
10'-0"
16"
END ELEVATION
24'-0"
A
B
SIDE ELEVATION
4"X6"
SECTION at A-B
10"
2'-8"
10'-0"
3"
2"
2"
END and SIDE VIEW of STAVE
4"X4"
2"X6"
CROSS-SECTION
3"X4"
2"X4"
4"X4"
LONGITUDINAL SECTION
Zinc Sheeting on Upper Side
PLAN and SIDE VIEW of SLIDING PLANK

FIG. 37

in the walls as they are being filled in with concrete. After the concrete has set and the wooden form has been removed, the interior of the tank should be washed with a thin paste of pure cement for the purpose of sealing any cracks and interstices and making the tank water-tight.

Wooden tanks in knock-down form may be purchased from some dealers in stockmen's supplies. In Fig. 36 is shown a general view of such a tank assembled, and details and dimensions of the same tank are shown in Fig. 37. An experienced carpenter or woodworker would doubtless be able to construct a tank along the same general lines as the one illustrated, but the work must be carefully done to insure a water-tight tank. An exhaustive description of the detailed drawing in Fig. 37 is scarcely necessary here, for it is sufficiently explicit to enable a competent workman to do the job, and unless such a workman is available it will perhaps be advisable to buy a tank outright, for a poorly constructed tank will be found to be extremely unsatisfactory and wasteful.

FEEDS FOR BEEF AND DUAL-PURPOSE CATTLE

27. The general principles of feeding as set forth in a section devoted to the subject are, of course, applicable in the case of beef and dual-pupose cattle as in that of any class of farm animal. The discussion here presented is not intended to be complete with reference to the feeds mentioned, but rather to point out special considerations with reference to particular feeds, that are of importance in feeding beef and dual-purpose cattle.

CONCENTRATED FEEDS

28. Corn.—Of all the concentrates, corn is the most largely used for the feeding of beef and dual-purpose cattle. It has been said that corn can be grown in every state in the Union, but it is most profitably grown in what is known as the corn belt, which includes the seven states of Ohio, Illinois, Indiana, Iowa, Missouri, Kansas, and Nebraska and those immediately

adjoining, and it is in this belt that beef production is most extensive. Corn is peculiarly suitable for use as a fattener, as its relatively high content of carbohydrates adapt it for this purpose rather than for the promotion of growth. Where corn flourishes no other plant furnishes such a large amount of nutrients per acre suitable for fattening cattle.

In general, there are three kinds of corn that should be mentioned in this connection, namely, flint corn, dent corn, and sweet corn. In flint corn, the starch is in a hard, flinty condition in which it is difficult for an animal to crush it, and it is more necessary with this variety of corn than with others to grind it for feeding to animals. In dent corn, a part of the starch is hard and part of it is in a floury condition, which makes the kernel more easily masticated by animals. The difference, if any, in the value of White dent and Yellow dent for feeding purposes is so slight that it cannot be measured. Sweet corn has a very hard, shrunken kernel, and is seldom used except to cut up green as forage in the summer or early fall. The dent varieties carry a smaller proportion of cob to grain than the flint varieties.

The cob of corn has very little feeding value even when finely ground, but sometimes serves a useful purpose in giving more bulk to a ration and furnishing a certain quantity of roughage. The practice of grinding corn, cob and all, or crushing it for feeding purposes, has gained considerable favor with cattle feeders. At the Illinois Experiment Station, however, a test was made from which it appears that for winter feeding, at least, broken ear corn is as satisfactory if not more so than either corn meal or corn-and-cob meal for feeding to cattle.

Certain by-product feeds derived from corn in the process of manufacturing starch, oil, and other materials, are also used for feeding. As examples of some of the common by-product feeds gluten feed, gluten meal, germ-oil meal, and hominy feed may be mentioned. Some of these are useful as supplementary feeds for cattle. However, if there is an abundance of corn grown on a farm it is seldom advisable to purchase extensively the corn by-product feeds.

29. Wheat.—Wheat is seldom used in the feeding of beef or dual-purpose cattle. There is at least one by-product, however, in the manufacture of flour which is most excellent in forming part of the ration of beef-breeding cattle and young and growing cattle, and this is, wheat bran. It is a bulky feed containing considerable woody fiber, but in practice it has proved to be one of the best supplementary feeds to be used in connection with corn and in some instances with oats for the feeding of beef-breeding cattle and young stock.

Wheat middlings, shorts, and low-grade flour, the latter being frequently spoken of as red-dog flour, are all similar products, but they are not much used in cattle feeding because of being too fine.

30. Oats.—Whole or ground oats form a most excellent feed for use in connection with corn meal and wheat bran in the ration of beef-breeding cows, bulls, and calves, although the price of oats in recent years has been such as to render their extensive use inadvisable.

31. Cottonseed Meal.—One of the most extensively used by-product feeds for the purpose of supplementing corn is cottonseed meal, and since this material is rich in protein and corn has a relatively low protein content such a combination is well suited to the requirements of cattle feeders. In the manufacture of cottonseed oil, the usual method is to remove the hulls of the seeds and subject the remaining portion to heat and pressure for the extraction of the oil. The residue, when dried and ground, constitutes cottonseed meal. Another process of oil extraction consists in simply subjecting the entire seed, unheated, to extremely high pressure. The residue of this process, commonly sold in cakes, is known as cold-pressed cottonseed cake. In this product there is a much larger proportion of the hulls and lint than in ordinary cottonseed meal, hence it has a correspondingly lower feeding value. In the South, where cottonseed meal is relatively cheap and abundant, it is fed at the rate of 6 to 8 and in some cases 12 pounds of meal per steer per day. In such instances the cattle are

seldom fed more than 4 months, and doubtless the general average is considerably less than this. In the North, cottonseed meal is advantageously used in the fattening of cattle at the rate of about 3 pounds per 1,000 pounds live weight of cattle daily. Cattle may be fed this ration over a considerable period without danger, whereas it is not deemed advisable to feed, for any considerable time, as large quantities as are fed in the South.

32. Oil Meal.—The material known as oil meal or as ground linseed cake is a by-product feed, being the residue left in the manufacture of linseed oil from flaxseed. Flaxseed itself is seldom fed to cattle because of its high commercial value. There are two processes used in the manufacture of linseed oil which gives to the by-product feed the name of either the old-process oil meal or new-process oil meal. The new-process oil meal is manufactured by treating the crushed and heated seed with naphtha. By the old process, the oil is extracted by pressure, as in the production of cottonseed oil. Nearly all of the linseed oil in the United States is made by the old process, and hence nearly all of the oil meal offered for sale is old-process meal. The protein in the old-process meal is somewhat more digestible than that in the new-process meal.

33. Soybeans.—The soybean has not been extensively used in the production of beef, largely because it has not been extensively grown where beef production is a prominent industry of the farm. It is believed that soybeans, which are rich in protein and fat, will eventually be more largely used in cattle feeding. They should always be ground and used in connection with other feeds. They could be advantageously used where corn is extensively grown, in about the same proportion that cottonseed meal is now used. The entire plant could also be cut up and put into the silo along with the corn and thus make a better balanced ration for cattle-feeding purposes and perhaps without the necessity for the purchase of other concentrated feeds rich in protein.

ROUGHAGE FEEDS

34. Alfalfa Hay.—The alfalfa plant flourishes in the Western States, reaching its highest state of perfection in California and producing large yields in Colorado, Utah, Montana, and adjoining states. Of late years, considerable alfalfa has been successfully grown throughout the corn belt, and often corn-belt farmers have found it profitable to ship in western-grown alfalfa for feeding to their beef and dual-purpose cattle. Alfalfa hay is of a character that keeps the animal in thrifty condition and is very valuable to use in connection with corn for finishing beef animals. It puts on a bloom that it is impossible to put on with any other kind of roughage, and the large amount of protein it contains makes it possible to maintain animals almost entirely on alfalfa, as it forms practically a balanced ration and is very palatable.

35. Clover Hay.—What is known as medium red clover hay is the standard roughage of the central and eastern parts of the United States. When cut at about full bloom it furnishes a higher proportion of digestible nutrients than when cut at any other time. After the hay passes through the full-bloom stage it becomes more woody, the leaves and finer stems fall off, and the hay is less nutritious and less palatable. On the other hand, if cut before this time the hay contains too large a percentage of water to be profitably handled. Clover hay does not carry so large a percentage of protein as does alfalfa hay, but on account of the difficulty in securing a satisfactory stand of alfalfa in the Central States, clover is much more widely grown and is looked upon as one of the standard crops on every well-managed farm. One-half to two-thirds of the ration for maintaining cattle can easily be made up of clover hay, and, with the exception of alfalfa, there is no better roughage that is better for fattening livestock.

36. Soybean Hay.—Soybeans will, as a rule, do well south of the forty-second parallel of latitude, which includes most of the corn belt, and certain hardier varieties are successfully grown in Northern Wisconsin. Soybean hay is of value

because it can be grown in a short period of time and is a means of supplying protein in a ration when other nitrogenous feeds are lacking. A serious drawback to growing soybeans is the difficulty in harvesting, as they are hard to cut and cure properly. Although little definite experimental work has been done along that line, soybeans promise to be good to use for silage in connection with corn.

37. Cowpea Hay.—Cowpea hay may be compared to soybeans in many respects. Cowpeas are less hardy than soybeans, but are a good crop south of the central part of the corn belt. In sections where cowpeas thrive, they are ranked above soybeans on account of their greater palatability and having finer, less woody stems. A Missouri feeding experiment, comparing the value of different roughages, showed that cowpea hay and clover hay were of equal value in producing gains when fed with shelled corn, but that cheaper gains were made when a carbonaceous roughage, such as corn stover, was substituted for a part of the leguminous roughage. When properly cured, cowpea straw has proved to be nearly as valuable a roughage as clover hay.

38. Timothy Hay.—Timothy hay has a high commercial value, due to its extensive use as a feed for horses doing hard work in cities, but it does not contain a proper proportion of nutrients and is not sufficiently palatable to make a satisfactory feed for cattle. It will usually be found more profitable to sell timothy at its market value and buy a leguminous hay to supply roughage for cattle. The feeding value of timothy for mature animals is increased if it is well matured. For young, growing animals, timothy should be cut before it is mature, as at this stage it is more palatable and gives more bulk than later.

The fact that the percentage of protein in timothy hay is very low makes it necessary to use a large quantity of nitrogenous concentrates to balance properly the ration either for growing or fattening animals, and this would in itself be expensive, not considering the high commercial value of the timothy hay. It has been found by experiment that it is in a class with

corn stover as a feed for cattle. A farmer ought also to take into consideration the fact that the growing of a crop of timothy for hay is very hard on the soil, while a crop of clover or alfalfa can be so handled as to add fertility to the soil as well as to furnish feed for the animals grown on the farm.

39. Oat-and-Pea Hay.—The combination of oats and peas is more generally used as a soiling crop in a dairy region than for hay. The yield from oat-and-pea hay exceeds that of clover, and on account of the high feeding value of the former, will probably receive more attention of cattlemen in the future than it now does. At present, this crop is grown most extensively in the northern section of the country beyond the corn belt. It is an excellent crop to sow early in the spring when clover and other meadows have been winter killed and it seems advisable to augment the hay crop.

40. Prairie Hay.—Good prairie hay has practically the same composition and feeding value as timothy hay for cattle. Prairie hay is not advised for use as a roughage in cattle feeding except where it is the only roughage available. Formerly, prairies in the West furnished large quantities of prairie hay, but with the advance of farming, relatively small areas of prairie hay remain.

41. Millet.—At the best, millet is not a palatable or a valuable feed for cattle, but, because of its hardy nature, quick maturity, and heavy production, it is sometimes used. Millet is valuable as a catch crop, but, on account of its woody nature, it should be thickly seeded to prevent the hay from being too coarse. For feeding purposes, millet should be cut before it is mature—in fact, soon after heading—because at maturity the stem becomes woody and the seed, being small and hard, is not easily digested. While millet is harmful to some animals when fed heavily, a limited quantity can be fed to cattle safely if it is not allowed to become too ripe and if care is used in feeding. A serious objection to millet is that it depletes the soil, probably worse than any other crop. Millet hay should be fed sparingly to cattle, as when fed abundantly it frequently causes scours and digestive disorders.

42. Cottonseed Hulls.—The hulls that are a by-product of cottonseed meal and cottonseed oil manufacture are widely used in the southern states as a cattle roughage. Various feeding experiments have proved that cottonseed hulls are of less feeding value than equal weights of either oat straw or corn stover. Although cottonseed hulls may be profitably used in the South, their feeding value will not warrant using them elsewhere as a commercial feed, since the expense of handling and shipping may easily exceed their feeding value, especially compared with other roughages that are usually available at a low cost. The feeding value of cottonseed hulls depends on the process by which the seed is removed from the hull, for sometimes part of the seed remains in the hull, in which case the feeding value is increased accordingly.

43. Corn Stover.—In composition and feeding value, corn stover closely resembles timothy hay, and, under some conditions, corn stover has proved as profitable a roughage as timothy hay in beef production. Although extensively used, it is not an ideal roughage for cattle. Different experiments have demonstrated that 1 ton of clover hay is equivalent to 3 tons of corn stover for either milk or meat production.

Corn stover is fed extensively throughout the corn belt, largely because it is a cheap roughage that cannot be profitably disposed of in any other way. Many cattle subsist upon it during the greater part of the winter months. After the corn is husked, the cattle may run in the field till late in winter and are then carried through the rest of the winter on shock corn or shredded fodder.

Cattle may be wintered at a low cost on corn stover, supplemented by a small grain ration, but corn stover alone should not be depended on too largely for milk production or for growing young animals.

SUCCULENT FEEDS

44. Silage.—Although silage may be made from a variety of crops, corn is looked on as one of the best crops for the silo, especially in the states where the corn plant flourishes. Corn silage is a carbonaceous roughage, and it should therefore be

fed in connection with some nitrogenous feed, as cottonseed meal or alfalfa, in order to furnish a balanced ration. The value of corn silage has for some time been recognized by dairymen and its use is now rapidly increasing among the beef producers. As a roughage for wintering a breeding herd it is unexcelled, and a number of valuable experiments have shown silage to be of great economical value in the finishing of cattle for the market. It forms a succulent portion of the ration and is almost invaluable as a feed to fall back on in case of a summer drouth which may destroy the pastures. The bunks for feeding silage in summer should be placed under a shed of some kind so that the sun will not strike the silage, as the hot sun will quickly dry it out and thus render it less palatable; also, the silo should be of such a size that at least 2 inches will be removed daily. For winter feeding, the bunks may be either outside or within the sheds, as only what is cleaned up readily should be fed in any case. Silage allowed to accumulate in troughs or about the door of the silo will become molded, and if eaten by cattle is likely to produce digestive disorders.

45. Beet Pulp.—In localities adjacent to beet-sugar factories, a by-product known as beet pulp is available and is of considerable value as a cattle feed. It contains about 90 per cent. of water, but the remaining 10 per cent. contains a sufficient quantity of nutrients to warrant its use. One ton of beet pulp is said to be equal to about 200 pounds of corn, and various feeding experiments seem to indicate that its value in meat production is about in this proportion. A mature animal will eat over 100 pounds of beet pulp in a day, but better results have been obtained from feeding a smaller quantity, say, from 70 to 90 pounds per day. Steers fed and fattened on beet pulp finish well and produce a good quality of beef. The pulp is preserved in silos, or in pits and trenches covered over with straw and earth to keep out air. The silo is the most economical means of storing the pulp, and by this method it may be utilized for a longer period. Beet pulp is especially valuable for winter feeding, as it supplies a succulent feed at a time that such feeds are hard to furnish. The use

of this material is for obvious reasons restricted to localities near beet-sugar plants, but dried beet pulp, which is identical with the product just discussed except that some of the excess of water has been removed, may be shipped to a considerable distance and fed to advantage.

46. Roots.—In many sections roots are extensively used for cattle feeding. The term roots as used here has reference to mangels, sugar beets, turnips, carrots, and rutabagas (Swedish turnips), which are particularly suitable for winter feeding. At that season of the year dry feeds are depended on to furnish the bulk of the feed, but any of the root crops mentioned are good to maintain the physical condition of cattle. The objection to root crops is that they require much hand work, which may make them too expensive for ordinary feeding. In meat and milk production, these crops may be classed with corn, and a combination of roots with other feeds has usually given slightly better results than dry feeds alone. Since corn is so extensively grown and the introduction of the silo has given the cattlemen a succulent feed for winter feeding, roots are not grown extensively except in regions where labor is cheap and a large variety of crops will not grow. Roots are extensively used in Canada and England, where corn does not ripen a satisfactory crop. In other sections, roots are grown for special purposes, such as finishing animals for the show ring or for producing a large milk flow. The yield from the principal root crops may exceed 20 tons to the acre, but they are not considered an economical feed for the use of the average stockman.

BEEF AND DUAL-PURPOSE CATTLE

(PART 4)

FOUNDING OF A HERD

GENERAL CONSIDERATIONS

1. Before purchasing breeding stock for the founding of a herd of beef or dual-purpose cattle, a person should consider a number of points. He should take into consideration the extent of his experience, the amount of capital available, the ideal type of animal that he has in mind and that he hopes ultimately to produce, the adaptability of his locality to a particular branch of the cattle business, and the principal breed of cattle raised in the locality.

In cattle breeding, as in other enterprises, an inexperienced person must proceed with caution if he is to succeed. If limited as to capital, he should begin in a small way and allow the business to expand as he gains experience. The experienced man, on the other hand, may, even though lacking in capital, often profitably purchase a herd of high-class animals at the outset, the profits from the herd making up the deficiency in capital. The man with plenty of capital is privileged, of course, to start as he chooses; he may enter the business extensively and trust to luck, or he may employ a competent herdsman to look after his cattle.

One of the essentials to the highest success in the breeding of any kind of livestock is that the breeder have in mind a

COPYRIGHTED BY INTERNATIONAL TEXTBOOK COMPANY. ALL RIGHTS RESERVED

definite ideal toward which to breed. The work of the great livestock breeders of all times has been characterized by persistent effort to attain an ideal. Unless a breeder has an ideal and constantly breeds toward it, his herd will lack the striking uniformity observed in the herds of the best breeders. So the beginner in cattle breeding should, before purchasing foundation stock for his herd, decide on the type of animal that he hopes ultimately to produce. If he has this ideal clearly in mind he can purchase breeding animals that approach the type he prefers.

If a person has the privilege of selecting the place where he is to establish his herd, he should choose a locality adapted to the branch of cattle breeding he desires to undertake. For instance, if a breeder intends to sell breeding stock, he should locate where there will be a demand for his stock. The higher the grade of stock produced, however, the less important is the factor of local demand. If a person is located and is selecting a breeding herd, his selection should be influenced to a considerable extent by the demands of the locality.

No matter how successful a breeder may be, there are many advantages in breeding the same kind of cattle as those that predominate in the community. Buyers of breeding stock are more likely to visit a community where there are several herds of the same breed than where only one herd is to be found. Also, when new blood is to be introduced into a herd, it is more satisfactory in every way to select animals near home.

SELECTING OF FOUNDATION STOCK

2. When a person has decided on the breed and type of cattle that he wishes to raise and is ready to start in the business, he is confronted with the problem of where to purchase animals reasonably. Although this problem is largely one that must be solved by each individual according to his conditions, is it usually the most satisfactory to purchase animals as near home as possible. The procuring of stock from neighboring farms saves transportation charges, enables the buyer to examine the cattle carefully with reference to merit and

healthfulness, and also makes it possible for him easily to ascertain facts regarding their breeding qualities.

It is not always possible, of course, to obtain desirable stock near home. When it is impossible, the breeder will find it necessary to purchase animals either from breeders in other localities or at the large livestock markets, such as Chicago, Kansas City, Omaha, St. Louis, Pittsburg, St. Paul, and Indianapolis. If pure-bred animals are desired, it will be necessary, in order to be sure that they are pure-bred and to obtain their pedigrees, to make the purchase from breeders. In case grade animals are wanted, it will often prove desirable to procure them from commission men at the livestock markets.

Pure-bred cattle may be purchased at private sale, or at the show ring, or at dispersion and annual sales of breeders. There is much in favor of buying at private sale. It gives the buyer time to look over the animals and satisfy himself regarding the health and type of the herd. In addition, it is often the case that animals can be purchased more cheaply at private sale than in any other way. In buying at the show ring the buyer must bid against other buyers who may want the animals for their show records and are, therefore, willing to pay more than they are worth for breeding purposes. Also, a show animal is likely to have been overfitted to such an extent that it will not be a sure breeder until it returns to normal condition, and, in fact, may never get over the effects. A dispersion sale may be made because the cattle are diseased or because they are poor breeders; for this reason, a breeder should be cautious about purchasing stock at such sales. Occasionally, there is opportunity to purchase good animals at dispersion sales, but the buyer should become informed regarding the reason for making the sale. Many of the best breeders hold regular annual sales. It is often as satisfactory to buy animals at these sales as at private sale, as the buyer has the benefit of the judgment of other cattlemen in regard to the worth of the animals.

The most desirable place to purchase cows for a dual-purpose herd is a locality where the breeders are striving to produce the dual-purpose type of animal. Better animals can usually

be obtained in such a locality than in the large markets, and in addition there is less danger of disease.

3. Selecting of Beef Breeding Cows.—Whether the foundation stock of a beef breeding herd shall consist of pure-bred or grade animals is dependent on the purpose of the breeder in founding the herd. If the purpose is to raise pure-bred breeding stock to sell at fancy prices, it will be necessary, of course, for the breeder to select as foundation stock pure-bred, pedigreed animals. If, on the other hand, the purpose is to produce stock for the feed lot, it will usually be the most economical to select as foundation stock grade cows with a high percentage of the blood of one or more of the recognized beef breeds.

When selecting either pure-bred or grade beef cows, a breeder should seek for animals that have merit and are healthy. A meritorious beef-breeding cow is low set; she has a broad, deep body; well-sprung ribs; smoothly set shoulders; a short neck; a short, broad head; a straight top line and bottom line; a long, level rump with plenty of width at the hips and pin bones; well-filled thighs, with the legs set well apart and well fleshed to the knees and hocks; and medium-sized bone in the legs and tail. The general conformation and appearance is symmetrical, smooth, and without angularity or coarseness on the one hand or evidence of delicacy on the other. The score card for beef breeding cattle given in a preceding Section gives the detailed requirements for animals of this class. Too much care cannot be taken to guard against securing breeding cows that are diseased. The two diseases that are to be feared most in the breeding of cattle are tuberculosis and contagious abortion. These diseases, as well as others, will be discussed in another Section.

It is extremely desirable to procure cows that are as uniform in conformation and breeding as possible, otherwise the offspring will vary greatly in conformation, markings, and, worst of all, in maturing qualities. A herd of cows uniform in type and breeding, all bred to a pure-bred sire of the same breed, will rarely if ever produce calves that vary materially in type

or the possibility of maturing at approximately the same age. It is much more difficult to purchase grade animals that are uniform than it is pure-bred animals.

One of the most important points in the selecting of beef breeding cows is to be sure that they are good breeders and mothers. Some cows are sterile and others breed very irregularly. It is obvious that such animals can be kept only at a loss, unless, perhaps, they are valuable pedigreed animals, in which case the dropping of an occasional calf may warrant keeping them. It is advisable, therefore, before purchasing cows to learn all the facts possible about their breeding qualities and the quality of their offspring. In the case of some strains of the beef breeds, the milking qualities have become almost extinct, so much so, in fact, that the dams are unable to suckle their offspring. This is a very objectionable characteristic and should be discriminated against.

For corn-belt and small-farm conditions it is better to purchase native stock than western, or range, stock. Range cattle are likely to be restless and wild and not suited to an environment where they must be kept confined.

4. Selecting of Dual-Purpose Cows.—It is not advisable, under present conditions, to select pure-bred cows of any of the so-called dual-purpose breeds for a herd of dual-purpose cattle. Grade cows can be secured that will be fully as efficient as pure breds, and besides, will cost less. The majority of dual-purpose herds are made up of grade cows, most of which contain considerable Shorthorn blood.

If grade cows are to be bought, the kind and grade must be determined by the purchaser according to his conditions. The best animals, or those having the highest efficiency in both beef and milk production, will be relatively high priced and hard to find. The beginner will probably find it more desirable to purchase a lower grade of cows, and then improve his herd by young stock that he will raise to take the places of the poorer individuals. This method is cheaper but requires a longer time to establish an efficient herd. Regardless of the grade of cows selected, all individuals should be uniform

in conformation, so that when bred to the same sire, a uniform lot of calves will be secured. Young cows are to be preferred, provided they are known to be breeders. A dual-purpose cow should have a clean-cut head; a broad muzzle; clear eyes; a smooth, short, but rather fine neck, indicating more milking quality than is noted in the average beef animal; smooth, well-fleshed shoulders and forearms; a deep, full heart girth; a deep, broad barrel with well-arched ribs; a straight, well-fleshed back and loin; a level, wide rump; well-fleshed thighs that are set well apart, giving space for a good udder; a good development of all milk-secreting organs; well-placed legs, with a good quality of bone; and above all should be healthy and vigorous. However, the conformation of the dual-purpose cow is not so firmly established but that it will vary with animals of different breeding.

It is even more undesirable to purchase cattle from the ranges as dual-purpose animals than as beef animals. Western cattle do not take kindly to handling, and in the case of mature cows there is danger of the udders being spoiled, due to the lack of care cattle receive on the range.

5. Selecting of a Herd Bull.—There are two considerations of prime importance in the selecting of a herd bull. The first consideration is that the bull should be pure bred; the second is that he should have all of the characters of a typical animal of the breed to which he belongs. Many persons who are not familiar with cattle think that because an animal is registered or is eligible to registry it must have merit. This is by no means true. A pedigree or certificate of registry has to do merely with the ancestry of an animal and not with its individual qualities. If anything, a cattle raiser should be more particular about securing individual merit in a registered or a pedigreed bull than in a grade bull, or one that is not eligible to registry. The reason for this is that a registered bull is more likely to stamp his character in his get than a bull of inferior breeding. In other words, an inferior registered bull is more likely to stamp his inferiority on his offspring than a medicore bull of doubtful ancestry.

Naturally, the one condition that has a tendency to limit the general use of pedigreed sires is the fact that they cost more than grade sires. However, a registered bull of good individuality can be purchased at a sufficiently reasonable price to justify most cattle raisers in buying such an animal in preference to a grade bull. It is important that the bull selected to head a herd shall be a good breeder. Some breeders pamper their young bulls to such an extent that the usefulness of the animals is impaired and consequently when they go into the herds of cattle raisers they prove unsatisfactory. It is well to avoid purchasing a bull that has been overfed on corn, as such an animal is likely to be a poor breeder. The best policy, in order to be sure that a bull is a breeder, is to insist on the owner guaranteeing him before the purchase is made. When possible, it is well to purchase a bull from a herd that has been tested and found to be free from tuberculosis.

A mature bull, if a good individual, is more satisfactory than one that has just arrived at the age of serviceability, but mature bulls are more difficult to secure than young ones, and it is usually not advisable to attempt to get them, for the reason that they are often simply culls that were not good enough to sell when younger. It will generally be found to be the most practical plan to purchase a well-grown calf or a yearling, being careful not to give him too much work to do until he is 2 years old or over. Occasionally, a tried sire that some other breeder has used for a time is available. A tried sire is, of course, always to be preferred to an untried one.

MANAGEMENT OF BEEF AND DUAL-PURPOSE CATTLE

MANAGEMENT OF A BREEDING HERD

COWS

6. Period of Heat in Cows.—Heifers first come into heat when they are between 4 and 18 months old. A mature cow will usually come into heat from 20 to 60 days after calving, depending on her health and whether the calf is taken from her or not. The signs of heat are much the same in the case of cattle as in the case of other farm animals. The animal shows signs of restlessness, the vulva becomes swollen and red, and there is a discharge of reddish mucus, accompanied with frequent urination. The period of heat in cows lasts from 12 to 24 hours and recurs regularly about every 21 days unless the animal becomes pregnant, in which case it ceases until after the calf is dropped.

7. Age at Which to Breed Cows.—The most common practice among breeders of beef and dual-purpose cattle is to breed heifers the first time when they are about 20 to 21 months old, so that they will calve when they are about 30 months old. It is not advisable to allow heifers to go much longer than the age specified before breeding them, as there is danger that they will get too fat to breed regularly. On the other hand, they should not be bred younger, as in that case they will not have attained their full growth before parturition, which might result in the retarding of their development. Slight variations from the age given may be made in case heifers have not made normal development; that is, if they are poorly developed at the normal breeding age the time of breeding them should be delayed somewhat.

8. Season at Which to Breed Cows.—It generally proves the most satisfactory to breed beef cows so that the calves will be dropped about the time the cows are turned onto grass in the spring. This is the most natural calving period. The date of turning cattle onto grass varies in different localities, and the time of breeding will need to be varied accordingly. In the corn-belt states the date of turning onto grass varies from the middle of April to the middle of May. As the period of gestation in cattle is, roughly speaking, 9 months, a cow should be bred in August to calve the following May. It is desirable to have calves as near the same age as possible, so that they will be uniform in size and condition when ready for the market.

Some of the advantages of having calves come in the spring are: First, the cows are bred at a season when they are most likely to come into heat regularly and at a time when they are more likely to stand to the service of the bull and become pregnant. Second, a herd can be much more cheaply maintained during the winter months if the cows are not suckling calves than if they are. Third, less equipment will be necessary for suitably caring for the herd than if the calves come in the fall. Fourth, if calves come in the spring and are well cared for and liberally fed from birth to maturity, it will not be necessary to carry them through more than one winter, as with good care and management they can be matured into baby beef and sold before the second winter.

When a breeder is situated so that fall calves can be properly cared for, there are some arguments in favor of fall calving. A herd invariably requires a great deal of care during the season when the cows are dropping their calves, and if this is during the fall and winter months, the breeder is likely to have more time at his disposal for giving proper attention to the herd. Also, calves that are not turned onto grass until they are about 6 months old seem to thrive better than those that are permitted to run on grass when very young. Another point is that fall calves can be carried through the second winter on rougher, coarser feed than is possible with spring calves that are passing through their first winter.

In the case of dual-purpose cows there is considerable advantage in fall calving. As dual-purpose cows are to be milked, those that become fresh late in the fall will produce the most milk during the winter when the highest price is obtained for dairy products. Cows that have been milked all winter after having calved in the fall will be revived in milk flow when turned onto grass in the spring; thus, by having calves come in the fall a dual-purpose cow will produce a maximum quantity of milk in both winter and summer. In addition, if cows calve in the fall, the owner will be enabled to utilize his time in winter in caring for them and the calves; whereas, if they calved in the spring, the care of the herd would interfere with other farm work. As a dual-purpose calf depends for a few months on milk as its feed, if dropped in the fall it will have the advantage of grass the following spring when it is weaned; if dropped in the spring, however, the grass season will likely end about the time the calf is weaned.

9. Breeding of Cows.—It is not a good plan to allow a bull to run with a herd of breeding females during the breeding season. This is true from the standpoint of both cow and bull, as during a period of heat there would be unnecessary worry to both animals. When a cow comes into heat she should be turned into a paddock with the bull and allowed to remain until a satisfactory service has been made. In the case of heifers or if an extremely heavy bull is to be used, a breeding crate should be made use of to prevent injury to the female. After a heifer or a cow has been served, it is best to separate her from the rest of the herd for several hours until she becomes quiet.

10. Signs of Pregnancy in Cows.—The first indication that a cow is pregnant is quietness and failure to come into heat at the regular time. A cow will usually begin to fleshen up in a short time after becoming pregnant, unless she is a heavy milker. After a few months an increased size of the abdomen will be noted, which will become more noticeable as parturition approaches.

11. Period of Gestation in Cows.—The period of gestation in cows is approximately 285 days, although there is likely

to be more or less variation from this time. In Table I is given a gestation table for cows that will be found helpful in keeping records of anticipated increase in the herd. This table is made up on a basis of a gestation period of 285 days.

12. Care of Cow at Calving Time.—About a week or 10 days before a calf is expected, the cow should be placed in an enclosure by herself. During the summer and early fall there is no better place for calving than a clean pasture or paddock. At other seasons of the year a comfortable, roomy box stall should be provided. Special care should be exercised to see that the stall is clean and sanitary, for many ills that affect new-born calves are due to filthy stalls. Before the cow is placed in the stall, all loose litter should be removed and the quarters thoroughly disinfected with a coal-tar disinfectant or some such preparation, after which clean bedding, preferably straw, should be supplied. All droppings and dirty bedding should be removed once or twice daily.

13. Parturition in Cows.—Parturition is preceded by an enlargement and swelling of the udder, and often by swelling of the abdomen in front of the udder. Several days before the birth of the young, a waxy secretion exudes from the teats and the vulva becomes red and swollen. A short time before labor pains start the belly drops, the rump flanks fall in, and the loin is depressed. When this occurs, the animal begins to show signs of uneasiness, such as lying down and rising again, and lowing. The labor pains will then begin, accompanied by violent muscular contractions, which will result in the birth of the young.

Within a short time after birth a calf will require feed, and it is always preferable that it should be allowed to suckle the dam, as the first milk, which is known as colostrum, exerts a purgative effect that is beneficial to the calf at this time. Usually the calf will be able to rise to its feet and take its first meal within a short time after being dropped.

14. Care of Cows While Suckling Calves.—For a few days after a calf is dropped, the dam should be attended frequently

TABLE I

GESTATION TABLE FOR CATTLE

Date of Breeding	Due to Calve	Date of Breeding	Due to Calve	Date of Breeding	Due to Calve
Jan. 1	Oct. 12	Feb. 1	Nov. 12	Mar. 1	Dec. 10
2	13	2	13	2	11
3	14	3	14	3	12
4	15	4	15	4	13
5	16	5	16	5	14
6	17	6	17	6	15
7	18	7	18	7	16
8	19	8	19	8	17
9	20	9	20	9	18
10	21	10	21	10	19
11	22	11	22	11	20
12	23	12	23	12	21
13	24	13	24	13	22
14	25	14	25	14	23
15	26	15	26	15	24
16	27	16	27	16	25
17	28	17	28	17	26
18	29	18	29	18	27
19	30	19	30	19	28
20	31	20	Dec. 1	20	29
21	Nov. 1	21	2	21	30
22	2	22	3	22	31
23	3	23	4	23	Jan. 1
24	4	24	5	24	2
25	5	25	6	25	3
26	6	26	7	26	4
27	7	27	8	27	5
28	8	28	9	28	6
29	9			29	7
30	10			30	8
31	11			31	9

TABLE I—*(Continued)*

Date of Breeding	Due to Calve	Date of Breeding	Due to Calve	Date of Breeding	Due to Calve
April 1	Jan. 10	May 1	Feb. 9	June 1	Mar. 12
2	11	2	10	2	13
3	12	3	11	3	14
4	13	4	12	4	15
5	14	5	13	5	16
6	15	6	14	6	17
7	16	7	15	7	18
8	17	8	16	8	19
9	18	9	17	9	20
10	19	10	18	10	21
11	20	11	19	11	22
12	21	12	20	12	23
13	22	13	21	13	24
14	23	14	22	14	25
15	24	15	23	15	26
16	25	16	24	16	27
17	26	17	25	17	28
18	27	18	26	18	29
19	28	19	27	19	30
20	29	20	28	20	31
21	30	21	Mar. 1	21	Apr. 1
22	31	22	2	22	2
23	Feb. 1	23	3	23	3
24	2	24	4	24	4
25	3	25	5	25	5
26	4	26	6	26	6
27	5	27	7	27	7
28	6	28	8	28	8
29	7	29	9	29	9
30	8	30	10	30	10
		31	11		

TABLE I—*(Continued)*

Date of Breeding	Due to Calve	Date of Breeding	Due to Calve	Date of Breeding	Due to Calve
July 1	April 11	Aug. 1	May 12	Sept. 1	June 12
2	12	2	13	2	13
3	13	3	14	3	14
4	14	4	15	4	15
5	15	5	16	5	16
6	16	6	17	6	17
7	17	7	18	7	18
8	18	8	19	8	19
9	19	9	20	9	20
10	20	10	21	10	21
11	21	11	22	11	22
12	22	12	23	12	23
13	23	13	24	13	24
14	24	14	25	14	25
15	25	15	26	15	26
16	26	16	27	16	27
17	27	17	28	17	28
18	28	18	29	18	29
19	29	19	30	19	30
20	30	20	31	20	July 1
21	May 1	21	June 1	21	2
22	2	22	2	22	3
23	3	23	3	23	4
24	4	24	4	24	5
25	5	25	5	25	6
26	6	26	6	26	7
27	7	27	7	27	8
28	8	28	8	28	9
29	9	29	9	29	10
30	10	30	10	30	11
31	11	31	11		

TABLE I—(*Continued*)

Date of Breeding	Due to Calve	Date of Breeding	Due to Calve	Date of Breeding	Due to Calve
Oct. 1	July 12	Nov. 1	Aug. 12	Dec. 1	Sept. 11
2	13	2	13	2	12
3	14	3	14	3	13
4	15	4	15	4	14
5	16	5	16	5	15
6	17	6	17	6	16
7	18	7	18	7	17
8	19	8	19	8	18
9	20	9	20	9	19
10	21	10	21	10	20
11	22	11	22	11	21
12	23	12	23	12	22
13	24	13	24	13	23
14	25	14	25	14	24
15	26	15	26	15	25
16	27	16	27	16	26
17	28	17	28	17	27
18	29	18	29	18	28
19	30	19	30	19	29
20	31	20	31	20	30
21	Aug. 1	21	Sept. 1	21	Oct. 1
22	2	22	2	22	2
23	3	23	3	23	3
24	4	24	4	24	4
25	5	25	5	25	5
26	6	26	6	26	6
27	7	27	7	27	7
28	8	28	8	28	8
29	9	29	9	29	9
30	10	30	10	30	10
31	11			31	11

to see whether the calf is taking all of the milk. In case a part of the milk is left in the udder it should be milked out regularly to prevent injury to the organ. As long as a cow is suckling a calf, she should have a sufficient quantity of good feed to stimulate a strong flow of milk. Heavy feeding, however, should not be practiced until the calf can take all of the milk. The best feeds to stimulate a strong flow of milk are pasture in summer and dry and succulent roughage supplemented by grain in winter.

15. Summer Feeding of Beef Breeding Cows.—In the feeding of beef breeding cows the object sought is to keep the animals in good, vigorous health without overfeeding them, which might result in sterility or irregularity in breeding. A breeder should understand at the outset that it is false economy to allow cows either in winter or summer to become markedly reduced in flesh, as it is always expensive to bring them back to normal condition, and even then they will not recover entirely for a considerable time. Breeding cows require little feed in summer aside from good grass, provided an abundance of pasture is supplied. Pasture grasses form nearly a balanced ration for breeding cows, and if the pasture is supplemented with other feeds, care should be exercised to see that they are balanced. It may be desirable to supplement pasture with grain in order to force the growth of suckling calves that are to be fattened at an early age or to put the cows in condition for market or show.

A variety of grasses makes the most satisfactory pasture for cattle. The following mixture has been recommended for seeding a permanent pasture on well-drained land of ordinary fertility: Kentucky blue grass, 4 pounds; Meadow foxtail, 1 pound; Perennial rye grass, 1 pound; Alsike or White clover, or both, 2 pounds; to this 1 pound of alfalfa seed may be added if desired. This mixture should be sown at the rate of about 16 pounds of seed per acre.

Pasture in rotation usually consists largely of clover and timothy. A clover-and-timothy pasture will not be available for pasturing as early in the spring nor will it be likely to afford

pasture as late in the fall as a blue-grass pasture, but during July and August it will be superior to blue grass.

To obtain the greatest benefit from a pasture, it should not be overstocked. Unlike horses and sheep, cattle prefer and thrive best on luxuriant pastures where the grass has obtained a good start. Overstocking a pasture will result in the grass being continually kept so short that the animals will not do well on it. Pastures also usually become short during the dry, hot months. This will usually occur in the latter part of July, August, and September. When a pasture becomes of little value because of either overstocking or seasonal conditions it is advisable to supplement it with some soiling crop. If the pasture becomes depleted early in summer it may be necessary to feed a little hay and grain in racks placed in the pasture field. In case the shortage of grass occurs late in summer it is probable that corn fed as a soiling crop will be the most satisfactory supplementary feed.

The winter ration should be continued for a few days after cows are turned onto grass in the spring. If this is done and the animals are turned on gradually, that is, allowed to graze for only an hour or so each day at first, there is little danger that the change in feed will cause derangements in their digestive tracts. Special care should be exercised in turning cattle onto clover in the spring or when they are not accustomed to it, as there is danger of bloat. Difficulty is seldom experienced, however, if the cattle are turned onto clover when it is dry and when they are well filled with other feeds. Under such conditions it is seldom necessary to remove them from the pasture; however, it is advised by some feeders to turn them onto the clover for only an hour or two each day for a few days, leaving them on a little longer each time.

Some stockmen prefer to feed soiling crops to cattle rather than to allow them to graze on pasture. It is usually possible to keep cattle on a smaller area of land where soiling is practiced than where pasturing is the method used, but considerable of the advantages of a soiling system are offset by the fact that soiling necessitates a great deal of labor. It is estimated that beef breeding cows can be kept for as little as 10 cents

per head per day on a well-arranged soiling system. However, according to this estimate it is cheaper to feed cattle on corn silage. Careful estimates from experiments show that beef breeding cows can be maintained on corn silage for only 7 cents per head per day.

Cattle on pastures should have access to salt at all times. Coarse salt is entirely satisfactory for cattle and costs very little.

16. Winter Feeding of Beef Breeding Cows.—The wintering of a beef breeding herd is not necessarily expensive, as it can be done in most instances largely with roughages that have small cash value. In fact, the advantage of keeping a beef breeding herd on a farm where a considerable quantity of roughage, particularly such by-product roughage as corn stover, oat straw, and wheat straw, is produced is that the cattle will utilize such feed profitably as part of the winter ration. Naturally, cattle will keep in better condition on clover or alfalfa hay than on the roughage mentioned, but it is more economical to use clover and alfalfa as a supplement to other feeds than as the principal roughage part of a ration. Silage, also, is one of the most satisfactory feeds to use as the basis of a winter ration for beef breeding cows, and is cheap.

The condition of cattle when put into winter quarters should largely determine the quantities and to a less extent the kinds of feeds that should be used. If the cows are considerably reduced in flesh, owing either to lack of good pasture or to prolonged suckling of the calves, it is advisable to feed them sufficiently to restore them to normal breeding condition. This can be done by a liberal use of silage and clover hay or by feeding corn stover and straw together with corn and oats. In some latitudes it is possible to winter cattle almost entirely outdoors on a pasture that has been saved especially for this purpose; in most latitudes, however, it will be found desirable to keep the herd in a small lot and depend entirely on feeds used in dry-lot feeding.

Throughout the principal cattle-producing regions, where cattle require dry-lot feeding in winter, corn and its products should form the basis of the ration. A ration composed of 18

pounds of silage and 4 pounds of clover hay per day per 1,000 pounds of liveweight of the animal, together with all the oat straw the cows will eat, will not only keep cows from losing in weight during the winter season, but will cause them to gain at the rate of from 1 to $1\frac{1}{4}$ pounds per head per day. If silage is not available, a daily ration of 10 pounds of shock corn and 4 pounds of clover hay, with straw at will, will take the herd through satisfactorily under normal conditions, but the latter ration is not as good as the first. Beef cows can be wintered on corn stover and straw supplemented with 2 pounds per 1,000 pounds of liveweight daily of clover hay. This ration will doubtless keep most herds from losing in weight, but is not recommended, being lower in nutrients than is desirable.

The quantities of feeds just given will ordinarily be found sufficient until calving time. After the calves are dropped, the feed should be gradually increased until the cows are receiving all that they will consume without waste, and some grain should be added to the ration. This grain may consist of equal parts of corn meal, ground oats, and bran, to which is added 10 per cent. of either cottonseed meal or linseed meal.

17. Feeding of Dual-Purpose Cows.—A dual-purpose cow, beside producing a calf of the desirable beef type, is expected to give a creditable performance as a dairy cow. The dairy performance of any cow capable of producing a fair flow of milk depends largely on the feed and care that she receives.

Good pasture can scarcely be improved on to produce a good milk flow. However, grass alone cannot be depended on to keep the milk flow at the maximum throughout the summer season. Some dairymen profitably feed a small quantity of grain, say from 1 to 3 pounds of bran or ground oats per day, as a supplement to pasture. In late summer, pastures usually begin to dry out, and as a result the cows fall off in milk flow. At this season of the year pasture can be profitably supplemented by soiling crops. Corn, after it is sufficiently matured, is probably the best crop to use for this purpose.

For winter feeding, some succulent feed should be provided. Silage is the preeminent winter dairy feed in all sections of the

corn belt. Silage can be fed to mature cows in quantities ranging from 30 to 60 pounds per day. In compounding rations for milk cows during winter, care should be taken that the feeds balance according to palatability, bulk, cost, availability, quality, and the physical effect of the feed. The following are desirable rations for dual-purpose cows on full feed for milk production:

Rations	Pounds
No. 1:	
Silage	20
Alfalfa hay	15
Beets	8
Bran	5
Shorts	3
Gluten feed	2
No. 2:	
Silage	40
Bran	4
Gluten feed	2
No. 3:	
Silage	30
Bran	8
Barley	3
Linseed meal	2
Mixed hay	15
No. 4:	
Alfalfa	20
Ground corn	5
Ground oats	5
No. 5:	
Alfalfa hay	14
Corn silage	15
Cottonseed meal	2½
No. 6:	
Corn stover	7
Corn silage	40
Cottonseed meal	2
Wheat bran	4½
Dried brewers' grains	4½

18. Care of Breeding Cows When on Pasture.—It is not a good plan to pasture breeding cattle in adjoining pastures, as the animals will stand along the fence and watch their neighbors when they should be grazing or lying in the shade. There is danger, too, that they will injure themselves by attempting to jump over the fence.

Other kinds of stock should not be allowed to run in a pasture with breeding cattle. Colts and mules will chase cattle, especially calves, often injuring them, and hogs are likely to hurt or even eat small calves if allowed in the pasture at calving time.

Plenty of shade in the way of sheds or trees should be provided in a cattle pasture to help keep down ravages of flies. Successful fitters of exhibition cattle provide dark stables for the cattle in daytime, and even hang cloth over the doorways to brush off flies as the cattle enter.

Cattle should always be driven slowly and quietly; it is especially important that they should not be run by a dog.

19. Care of Breeding Cows During Winter.—In caring for breeding cows in winter, it is important to make them take sufficient exercise to keep vigorous and healthy. This is particularly important in the case of pregnant cows. One of the best means for insuring that breeding animals will get enough exercise is to allow them to browse in stalk fields or require them to go some distance to get water.

Pregnant animals, especially, should not be compelled to walk over icy places or through deep mud. In fact, they should not be subjected to any condition that might cause abortion or other injury.

20. Eliminating of Undesirable Beef Cows From a Herd. In order for a cow to produce a good calf for either early marketing or for breeding purposes, it is necessary that she should give a good flow of milk that will keep the calf growing continually. Some cows, even though very plain looking themselves, will produce superior beef calves, because of having a good milk flow. It should be the purpose of a breeder to keep only such animals as produce good calves; all others should be eliminated from the herd. No matter what the individual excellence of a cow may be, unless she will produce a high-grade calf each year she should not, as a rule, be kept.

There are other reasons besides that of being poor producers, for cows being undesirable in a herd. A vicious animal that abuses the other cows may easily do more damage than she is worth as a breeder. Some cows acquire such habits as jumping over or creeping through fences and may soon teach these to the rest of the herd. All such cows should be sold or slaughtered, as their presence in the herd will cause constant trouble.

21. Eliminating of Undesirable Dual-Purpose Cows From a Herd.—In addition to the points that have just been mentioned in regard to the eliminating of beef cows, the breeder of dual-purpose cattle must give attention to the milk production of individual cows. In order to know exactly what the cows are doing, use should be made of a Babcock testing outfit. Too much dependence should not be placed on the results of the test, however, without considering the quantity of milk given by each cow throughout the period of lactation. A cow that gives a large quantity of milk of high test daily for a few months may not be as desirable as one that gives less and poorer milk daily, but whose lactation period is considerably longer. It is the yearly production that indicates a cow's value from the dairy standpoint.

If a breeder is to emphasize the dual-purpose use of his herd, he must not be misled by the Babcock tester, as milk production must be sacrificed in order to secure efficiency in beef production. However, a wise use of the tester will aid in establishing the dual-purpose efficiency of the herd.

HERD BULLS

22. Handling of a Herd Bull.—Experienced breeders agree that it is not advisable to allow a herd bull to run with the herd, at least during the breeding season. If allowed to do so, the bull may worry to the extent that his breeding powers will become impaired. This is especially true where another pasture is alongside that in which the herd is running and there are other cattle and possibly another bull to attract attention. Aside from the fact that under such conditions the bull will fret constantly, he will find an opportunity sooner or later to get through the fence and consequently his regard for fences will disappear and with it his regard for man. Another advantage of keeping the herd bull separate from the herd is that a record of the service date of each cow can be kept, so that it can be definitely known when each cow is due to calve. Then, too, the bull can serve a larger number of cows than when permitted to run with the herd.

The best plan for handling a herd bull is to keep him in a roomy paddock and bring the cows to him when they are to be bred. This paddock should be sufficiently large to furnish ample pasture for the bull and to give him an opportunity to get plenty of exercise. If the bull is required to graze in order to get forage, he will probably receive sufficient exercise to keep in a healthy breeding condition. A paddock for a bull should be well fenced and provided with shade, water, and shelter.

It is important to keep the paddock, and more especially the stable, of a bull free from mud and filth. If everything is kept clean, there is little danger of the bull contracting foul feet. Foul feet are to be guarded against in all animals, but more especially in a bull, because he is probably standing in a stable more and is harder to treat if affected than most other animals.

During the winter months it is a good plan to have the bull paddock situated near the cattle lot or separated from it by a single strong fence, so that the bull may see other cattle and get exercise by walking along the fence, as he will do. If the bull is not compelled to take exercise and is located by himself, he is apt to become so indolent and fleshy that his breeding powers will be lessened. A bull should be kept under control at all times; he will respect his herdsman as long as he is quietly treated but made to feel that he is not master.

As a rule, bulls should be dehorned in calfhood, as at that time the operation is extremely simple. As a precaution, a bull ring, such as may be secured from any dealer in stockmen's supplies, should be placed in the animal's nose, preferably before he reaches maturity. In handling a vicious bull, a strong stick about 3 feet long and having a snap affixed to one end is attached to the bull ring by means of the snap. The attendant can easily handle the most unruly bull with this device by merely keeping his head elevated. No bull can do much damage unless he is able to get his head down.

23. Feeding a Herd Bull.—A herd bull should be fed in such a way that he will be kept in good, thrifty condition without

becoming too fat. If a bull cannot be maintained in proper condition without giving him abnormal quantities of feed, it is safe to conclude that he has qualities and characteristics that unsuit him for serving as a sire in a beef herd. The feeding of large quantities of roughage and of such heating feeds as corn should be avoided. Cases are known where bulls have been fed so liberally on choice clover or alfalfa hay that they developed paunches that materially interfered with their sureness as breeders. Plenty of green succulent feed should be supplied during the summer. If the paddock does not furnish sufficient forage, it can be supplied from soiling crops. In winter, roots and silage are good succulent feeds.

A good grain ration for a herd bull is as follows: Corn, 40 per cent.; oats, 30 per cent.; bran, 30 per cent. This ration, with roughage, if fed to a bull in as large quantities as he will clean up, will not endanger his breeding powers or condition. The ration that is fed should, however, vary according to the individuality of the animal. For example, if a bull is somewhat sluggish in temperament, it would be advisable to substitute some less heating feed for a part of the corn in the ration just recommended.

24. Use of a Herd Bull.—For active service in a large herd, a bull should be well toward 2 years of age; however, a young bull may be used on a few cows when 1 year old to try out his worth as a breeder. Between the ages of 1 year and $1\frac{1}{2}$ years, a bull should not be allowed to serve more than eight or ten cows; a 2-year-old bull may safely serve from twenty to thirty cows in a year or season; after 3 years of age a bull may be considered a mature breeder and will be capable, if vigorous, of four services a week or even one a day for a short period of time, say a month or six weeks. The number of cows that may be served in a year by a mature bull should vary from thirty to sixty, depending on the breeding condition of the bull.

If a bull is handled properly, the period of his usefulness should continue until he is 8 or 9 years old or even longer. The best offspring of a bull, however, are usually produced in the period from the time he is 3 years old until he is 7 years

old. When a bull becomes impotent, or sterile, it is usually due to errors in feeding and lack of exercise rather than to excessive service.

25. Disinfecting a Bull.—When a new bull is introduced into a herd, it is never known but that he may carry the germs of some contagious disease, brought from the herd where he was secured or received during shipment. It is a good plan, therefore, to disinfect him before allowing him to associate with other cattle and especially to serve a cow. Disinfection may be accomplished by dipping, spraying, or thoroughly washing the animal and douching the genital parts with a syringe. Any animal dip will be suitable for the purpose, or a 5-per-cent. solution of carbolic acid may be used to cleanse the sheath.

CALVES

26. Management of Beef Calves.—Prior to the time a calf is weaned, milk will constitute the greater part of its feed. After it is about 2 weeks old, it will follow its mother a part of the time and begin to take the same kind of feed that she eats. If a little grain is fed to the cow when the calf is a few weeks old, it will soon learn to eat such feed, provided the grain is placed in a low feed box. As soon as the calf is eating grain regularly, it should be allowed to eat from its own feed box away from the dam. The quantity of grain should be gradually increased as the calf grows and the flow of milk lessens. A good grain ration for a calf is corn, 3 parts; bran, 3 parts; oats, 3 parts; linseed meal, 1 part. This ration will not cause a calf to become so fat that its breeding powers will be impaired. A calf that is nursing its dam will eat about 1 pound a day of this mixture when 3 months old; the quantity should be gradually increased until at 6 months of age the calf will be getting 3 pounds a day.

In a strictly beef herd a calf is usually weaned between the ages of 3 and 8 months. Some breeders of exhibition cattle, where economy of production is of secondary consideration, allow a calf to nurse its dam until it is upwards of a year old.

In such cases, the methods of managing the calves are exceedingly numerous and will not be discussed here. If a calf has been taught to eat hay and grain before being weaned, it can be abruptly taken away from the cow. As soon as this is done an increased allowance of the hay and grain that the calf is accustomed to should be fed to it and about 1 pound of linseed meal, cottonseed meal, or bran given to replace the milk.

It pays always to keep calves in a healthy, thrifty condition, because at no other age can gains be secured with such small quantities of feed. Calves weaned in the fall, when good pasture can no longer be supplied, need to have especially good care during the winter. The ration should consist of grain and good nitrogenous roughage. Oats are especially desirable for feeding to young growing stock. A grain ration consisting of 2 parts of corn meal, 2 parts of oats, and 1 part of a nitrogenous concentrate, fed with a limited quantity of clover or alfalfa hay supplemented with some cheaper roughage, such as stover, is excellent for calves. If the object is simply to grow calves well during the winter without fattening them, the grain feed should be limited so that roughage will make up a large percentage of the ration. A large quantity of roughage has a tendency to distend the digestive tract, making the animal capable of consuming large quantities of feed later in life. The grain ration should be limited to 3 or 4 pounds for a calf from 6 to 8 months old.

If a calf is weaned in the spring about the time the cow is turned onto grass, little supplementary feed will be required. The feed given to the calf before it was turned onto grass should not, however, be reduced too suddenly. If the pasture is good a calf should make good gains if fed daily about 2 pounds of grain of a nitrogenous nature.

The following winter the calf may be treated much the same as older cattle of the breeding herd. Silage supplemented with from 1 to 3 pounds of nitrogenous grain and from 3 to 5 pounds of clover or alfalfa hay per day will keep the calf thrifty. The proportion of grain to roughage and the kind of roughage fed will necessarily vary according to the use to which the calf is to be put and the rapidity of growth desired.

27. Management of Dual-Purpose Calves.—In the management of a dual-purpose herd it is necessary to raise the calves largely on skim-milk. If the calves were allowed to suckle the cows for any considerable length of time, as in the case of beef cows and calves, much of the value of the cows as dairy animals would be lost. It is considered advisable by most breeders, however, to allow a dual-purpose calf to run with its dam for about from 7 to 10 days after being dropped. During this time the milk of the cow will be unfit for human consumption but admirably adapted to the needs of the calf. Some breeders prefer to take a calf from its dam before it has had an opportunity to nurse. An advantage of this method is that it is easier to teach a calf to drink from a pail if it has never suckled. Another advantage is that both the cow and the calf will be less discontented than if they are allowed to run together for several days before being separated.

If a calf has become accustomed to nursing its dam, a little patience will be required to teach it to drink from a pail. Preparatory to receiving the first lesson, the calf should be allowed no feed for 12 hours. Fresh whole milk of a temperature between 95° and 100° F. should be used. The calf should be placed in a corner of a stall, where the attendant may secure it by standing astride its neck. A bucket containing the milk may now be placed on the floor in front of the calf. The calf's head should then be gently but firmly lowered into the pail, care being exercised not to force the nostrils beneath the milk. In most cases the calf will drink at once, particularly if the attendant will insert his finger in its mouth while the latter is immersed in the pail of milk. If the calf does not drink after repeatedly immersing its nose as directed, letting it fast for another 12 hours and then repeating the operation will almost invaribly result successfully.

As soon as the calf has been taught to drink it should be fed regularly three times a day. At each feeding the calf may be given from 3 to 6 pounds of freshly drawn milk. The exact quantity will depend on the size and vigor of the calf, and the quantity should be increased gradually and regularly as the animal grows. No fixed rule for this can be given; the judgment

of the feeder must determine the quantity for each case. The milk should always be fed at from 95° to 100° F. in order to avoid scours. In case scours start, it is well to feed some blood meal. All pails and mangers should be kept clean and sweet to prevent disease.

After a calf has become accustomed to drinking from a pail the milk used may be gradually changed from whole milk to part and finally to all skim-milk. For the good of the calf, the change should not be undertaken too quickly nor while the calf is too young. If a calf is vigorous it may receive all skim-milk when it is 4 weeks old; if it is not vigorous it may be advisable to keep it on whole milk until it is considerably more than 4 weeks old.

When a calf is 3 or 4 weeks old it will begin to nibble feed if any is available. At this time small quantities of good clover or alfalfa hay may be given and the calf encouraged to eat all it wants of this feed. Concentrated feed in the form of wheat bran, corn meal, ground oats, etc. may also be placed in boxes in order that the calf may acquire a taste for such feed. For a grain ration after the calf has begun to eat, nothing is superior to a mixture of equal parts, by weight, of wheat bran, corn meal, and either whole or ground oats, with 10 per cent. of old-process linseed meal. This ration may be continued until the calf is old enough to wean. In addition to these feeds, corn silage and pulped roots such as turnips and rutabagas are desirable for calves. Skim-milk calves should be weaned at about 6 months of age. Owing to the fact that they are generally more accustomed to eating grain and roughage than calves permitted to nurse their dams, they suffer less inconvenience and shrinkage at this period than the latter.

MARKETING OF BREEDING CATTLE

28. Advertising of Breeding Stock.—The methods employed in advertising a herd of breeding cattle should be determined by the class of buyers that the breeder desires to reach. If it seems likely that the best field for sales will be among local breeders, local advertising should be done. Local

advertisement may be secured by having the pastures located near highways so that the public can see the cattle, by inserting notices and display advertisements in local publications, by exhibiting the best animals at local fairs, etc. If the cattle for sale are high-grade, pedigreed animals and it is desired to attract buyers from a distance, advertising should be done in specialized livestock journals and the cattle should, if possible, be exhibited at a few of the large fairs or livestock shows.

A breeder should use an attractive letter head and should exercise care in handling his correspondence. He should have circulars printed describing and illustrating the animals for sale, so that in case inquiries about stock are received by mail, a full description can be forwarded with little trouble.

One of the most important points for an advertiser of livestock to bear in mind is that all statements made in advertising matter should be accurate. It is easy for a breeder to make unwarranted claims for his stock, but deception of this kind soon comes to light and the breeder will find that he has no market for his animals. It is always better when advertising stock to underestimate the animals rather than to overestimate them.

29. Methods of Selling Breeding Stock.—There are two general methods by which a breeder may dispose of breeding stock, namely, private sale and public sale. By the former method, stock may be sold at the farm, at shows, or by mail orders. The private sale has many advantages for both the breeder and the buyer. The breeder has an opportunity to show not only his sale stock but his breeding herd, to tell the buyer his aims in breeding, and to discuss the individual merit of animals. The buyer, on the other hand, can form an opinion of the breeder and his work, can learn his methods, and can ascertain facts about the breeding herd, as a whole, as well as about the animals he contemplates purchasing. The breeder, in order to sell all of his surplus stock by private sale, must establish a reputation as a breeder and be a judge of the value of the animals he has to sell. After the reputation of a herd is established, the breeder will be able to sell his stock at less

expense than is attached to public sales. Some breeders prefer to sell breeding stock at livestock shows. This is an expensive method of selling, however, as it is necessary to have the stock in show condition, which requires work and expense. Then considerable expense is entailed in transporting the cattle to the shows and in caring for them while there. Although there may be a demand for stock at fairs and shows and the animals may sell for full value, the buyer is likely not to be satisfied with his purchase. Animals fitted for the show ring are likely to go down in condition and prove to be poor breeders, if placed in other hands.

The sale of pure-bred breeding stock by mail order is a growing practice. Many animals may be disposed of in this way, particularly if the owner has established a reputation for honesty and integrity. If a breeder desires to build up a large correspondence business, however, he must be very careful in regard to statements he makes to prospective buyers.

The public sale as a method for selling stock has some advantages over the private sale. One advantage is that a public sale affords more advertisement to a herd than can be obtained by private sales. A public sale attracts the attention and possibly the presence of a large number of buyers, and besides, the catalogs and other literature sent out to advertise the sale indirectly advertise the herd. Another advantage of the public sale over the private sale is that in fitting animals for a public sale all of the work may be done at one time and the returns will all come in at the same time, whereas in the case of private selling the work of fitting the animals is prolonged indefinitely and the returns come in irregularly. The disadvantages of public sales are the large expense incurred, the possibility of bad weather interfering, and the uncertainity as to whether stock will be in condition at the time of the sale.

It is essential for the sake of advertisement that a breeder treat all visitors and prospective buyers courteously. When holding a public sale, a breeder should furnish lunch, pay hotel bills of buyers while in town, and provide conveyance to the farm from the station.

In most sales of breeding stock there is an implied guarantee that the animal is a breeder, and advertisement of stock in a reliable publication is considered a guarantee that the animals advertised are reliable breeders. In fact, it is usually considered that a breeding animal is guaranteed unless it is otherwise stipulated. Technically, a 1-year-old bull that has sired one or two calves is a breeder, but cattle breeders in general consider that a bull, in order to be considered a reliable breeder, should get with calf at least 70 per cent. of the cows he serves when not running with the herd. A cow is considered a breeder if she has a calf at foot at the time of the sale, or if she has failed to come into heat for four consecutive periods after being bred; a heifer is considered a breeder if she came into heat regularly up to the time of being served, after which her heat periods ceased. Usually bulls are guaranteed to breed satisfactorily for a period of one year following the sale, provided they are cared for properly. Cows are usually guaranteed for 6 months. A guarantee given by many reliable breeders is that after an animal has been tried for a period of 90 days and found not to be a breeder, it may be returned to the former owner at his expense and the purchase money will be refunded. If the animal is returned for other reasons, however, it must be at the buyer's expense. The breeder has a right to try all returned animals to satisfy himself that they are not breeders. Young animals that have been properly cared for seldom prove to be non-breeders, although some time may be required for an animal to become acclimated when taken to a new region. A breeder should do no more than guarantee to refund money and transportation charges on a non-breeder.

The success that a breeder will make will depend in a large measure on the personality of the man. One breeder will make a success with private sales and another will be the most successful with public sales. The local reputation of a breeder as a man and the general appearance of his premises count for a great deal in determining his success in the breeding business. There is no better advertisement for any phase of agricultural enterprise than well-kept premises. This is particularly true in the case of high-grade breeding farms.

30. Shipping of Breeding Stock.—A breeder should take as much care in shipping breeding stock that he has sold as he would in shipping his own stock. The cattle should be fed well and watered before being loaded, and good halters should be placed on all of the animals. Bulls should be rung before being shipped but should never be tied in the car by the rings, as the jerking of the train would be likely to make their noses sore. It is advisable to tie cattle at the side of a car rather than at the end. The shipping cars should be well bedded and the animals loaded as shortly before shipment as possible, especially if they are to go a considerable distance.

MANAGEMENT OF CATTLE FOR MARKET

31. Management of Baby-Beef Cattle.—Calves that are to be finished as baby beef should have a full ration at all times and should not be allowed to lose their milk flesh, which is known as *milk bloom*. It should be understood at the outset that only well-bred calves of good to choice quality can be satisfactorily matured in the time available for producing baby beeves. Although 2-year-old and older cattle can be finished for market in from 3 to 8 months, depending on the quality and condition of the cattle and the methods of feeding, baby-beef cattle cannot be satisfactorily finished in less than from 8 to 12 months.

When providing feed for baby-beef cattle it should be borne in mind that the appetite of calves is more fickle than that of older cattle, and consequently it is necessary to provide a better quality of roughage for young animals than for older ones. Assuming that the feeding period begins in the fall, the ration for baby-beef calves may be made up of a relatively large percentage of roughage, provided roughage of good quality, such as clover hay, alfalfa hay, or silage is available. If no nitrogenous roughage such as clover hay or alfalfa hay is to be had and silage is fed, cottonseed meal or linseed meal should be used as a supplementary feed. Corn silage has been found to be a desirable feed for baby beeves, provided a sufficient quantity of a concentrate such as corn, cottonseed meal,

linseed meal, etc., is added to the ration to obviate the necessity for the consumption of too large quantities of the silage. The majority of cattle feeders do not have corn silage. In this case, dependence must be placed on corn as the basis of the concentrated part of the ration, and it is very desirable that clover or alfalfa hay form the basis of the roughage part of the ration. Oats are frequently available and are excellent in the earlier stages of feeding, but are rather too bulky to feed extensively after the first few months; in other words, they are a good feed with which to start calves. Shelled corn, also, may be used with good results in the ration of calves.

The following rations are suitable for feeding to baby-beef calves, the quantities given being the average per day for a feeding period of from 250 to 300 days. The exact quantity of feed to give at any particular time will depend on the appetite of the animals and the stage of the feeding period.

SUGGESTED RATIONS

RATIONS	POUNDS	RATIONS	POUNDS
No. 1:		No. 3:	
Shelled corn	12	Corn and cob meal	14
Cottonseed meal	2	Cottonseed meal	2
Clover hay	4	Alfalfa hay	8
Silage	8		
No. 2:		No. 4:	
Corn and cob meal	14	Corn and oat meal	12
Cottonseed meal	2½	Bran	2
Clover hay	4	Clover hay	8
Silage	8		

32. It should be the aim of a feeder to keep his calves thriving and gaining from 1 to 1½ pounds each daily during the winter months so that they will go on pasture in the spring in good flesh but not as fat as they can be made. Cattle in too fat condition do not make as good use of grass as cattle in moderate condition. As soon as the calves are turned onto grass the roughage part of the ration should be decreased to a quantity that they will readily clean up, but the grain ration should be continued.

Heifer calves can be finished for market from 30 to 60 days sooner than steer calves, but will, of course, bring a slightly lower price than the latter. Occasionally, a few heifers in a drove of steers can be sold at the same price as the steers. Although baby beeves may be fattened and marketed as early as July, it is generally better practice to feed them through the summer, marketing them in October, November, or December.

The great bulk of so-called baby beeves are not fed liberally enough and consequently are not sufficiently fat when they reach the market. The result is that the cattle feeder is disappointed because his cattle do not bring the price that he expected. It is safe to say that it is impossible to get a calf or yearling too fat for a large market, and other things being equal, the fatter they are the higher the price they will bring.

33. Management of Stockers.—A great many cattle raisers prefer to keep their calves for the production of prime steers rather than to market them as baby beef. In this case a much lighter ration is fed to the calves than to those intended for baby beef. In feeding stocker calves the aim should be to keep the animals in fairly good condition on the most economical feeds available. For this purpose there is nothing better than pasture in summer and coarse roughage with corn in winter. The quantity of feed given will depend on the age and appetite of the calves.

The preceding statement in regard to the feeding of stocker calves applies in a general way to the feeding of stockers of any age. It is, obviously, necessary to feed to stockers only such feeds as will cause them to make steady gains at a minimum cost. A stocker should be fed so that when it is placed in the feed lot for fattening it will be in a thrifty condition and capable of consuming large quantities of feed. Stockers are usually pastured in summer and maintained on cheap roughage and corn during the winter.

34. Management of Feeders.—Two general systems for the feeding of cattle for market are in vogue at the present time. These are known as *short feeding* and *long feeding*. **Short feeding** is the process of feeding cattle but a short time,

say from 60 to 120 days, in preparing them for market. **Long feeding,** on the other hand, is the process of feeding cattle several months, say from 6 to 12 months, before they are marketed. By the short-feeding system it is possible to feed several droves of cattle a year. It is impossible, however, to produce finished, high-grade beeves under this system of feeding. To make a success of the short-feeding system, a feeder must have unusual buying and selling facilities, in order to take advantage of a depressed market for buying and a strong market for selling. A feeder that practices long feeding is more independent of market facilities than the short feeder, as he handles fewer cattle and is able to shorten or lengthen the feeding period according to the condition of the market.

35. Two methods are practiced in the short-feeding system: First, the buying of aged, thin-fleshed cattle and "warming them up," a process that consists of feeding them liberally for from 60 to 120 days, and, second, the buying of well-fleshed cattle that have been marketed in a half-fat condition and finishing them. If the first method is the one chosen, low-grade cattle of plain quality are usually purchased. Such cattle will not finish into choice beef even on a long feed, and a short feed will give all of the finish that it is profitable to secure. Short-feed cattle of this type, although not in demand in a strong market, will kill fairly well. If the second method is chosen, good cattle that have been disposed of for some reason, such as a lack of feed, are purchased. Such cattle are in condition to finish well, but there is a possibility that they may, for some unknown reason, be poor feeders.

The success of the short feed depends largely on the ability of the feeder to judge and buy cattle and his skill in putting the cattle on full feed in a short time. It is important in this system to get cattle with as much age as possible. Cattle under 2 years old should never be selected, because a young animal placed on heavy feed for a short time will put most of the feed into growth, whereas in the short-feeding system it is desired to obtain as large a gain in fat as possible in the time available. The cattle must be thrifty, but if they are to be

"warmed up," it is better that they be decidedly lacking in flesh, as the lower the condition of a thrifty animal, the more rapid will be the gains in weight, especially in the case of mature animals.

In short feeding, the cattle must be put on full feed quickly and fed heavily on a highly concentrated ration. If the animals are well fleshed and the feeder is certain that they are accustomed to a heavy grain ration, they may be started at once on practically a full feed of grain. In this case, the ration can consist wholly of ear corn or corn and cob meal supplemented with cottonseed meal, although a small quantity of roughage is usually fed. If animals are in thin condition and not accustomed to heavy feeding, it will be necessary to get them on full feed gradually. A good plan in this case is to feed at first a ration consisting of two-thirds hay, preferably chopped clover or alfalfa, and one-third corn. This ration may be gradually changed until at the end of a month the ration will consist of one-half or less of hay and the rest grain. Toward the end of the feeding period the ration may consist largely of corn, but if the nitrogenous roughage is reduced to a small quantity, cottonseed meal or some other nitrogenous concentrate should be fed at the rate of from 2 to 3 pounds per steer per day.

Cattle in thin condition that are to be short fed should receive at the start of the feeding period all of the roughage they will clean up. It is desirable to feed in large quantities a good legume hay or some succulent feed; this will cause the digestive tracts of the animals to become distended and will put their systems in good condition so that they will be able to consume large quantities of feed later. Silage is one of the best feeds for this purpose. At first the silage should be fed with hay but after a week the steers may be fed all of it they will consume. In a few days, grain may be gradually substituted for the silage until within a month the animals are receiving a full ration.

36. The following are suggested rations for the fattening of cattle. It is likely that these rations will need to be modified

to suit individual conditions, but they will give an idea of the kinds and quantities of feeds to give. The rations given are for animals on full feed and may be used for either long or short feeding.

SUGGESTED RATIONS

RATIONS	POUNDS	RATIONS	POUNDS
No. 1:		No. 5:	
Ear corn	20	Ear corn	15
Linseed meal	3	Corn silage	25
Clover hay	8	Alfalfa hay	5
No. 2:		No. 6:	
Shelled corn	18	Ear corn	16
Linseed meal	3	Cottonseed meal	3
Clover hay	9	Corn silage	32
No. 3:		No. 7:	
Ear corn	18	Alfalfa hay	5
Cottonseed meal	1	Corn stover	5
Alfalfa hay	10	Corn	18
No. 4:		No. 8:	
Ear corn	14	Barley	15
Linseed meal	1½	Linseed meal	1½
Shock corn	14	Clover or alfalfa hay	16
Clover hay	8		

At the end of a long feeding period the cattle will be consuming a larger percentage of concentrate compared to roughage than is indicated in the suggested rations. For example, in a ration of corn, linseed meal, and clover, the clover may be reduced to from 2 to 4 pounds per day when the cattle reach a high condition.

In the Southwest where cottonseed hulls can be secured at a reasonable cost for roughage, the following ration will prove satisfactory:

	POUNDS
Kafir corn (chopped)	16
Cottonseed meal	3
Cottonseed hulls	12

242—42

37. For the fattening of cattle for market, home-grown feeds should be used as much as possible, as cattle feeding should be a method of marketing the feeds grown on the farm. Corn, corn silage, and clover or alfalfa hay constitute a very satisfactory and economical ration; if alfalfa hay is fed it will furnish nearly enough protein to balance the ration, but if clover hay is used, enough cottonseed meal or other highly nitrogenous concentrate should be added to make a balanced ration. Where silage is fed, cottonseed meal is better than linseed meal, as it is not so laxative. If timothy hay, corn stover, or straw must be used as roughage, from 3 to 4 pounds of linseed meal per 1,000 pounds liveweight of cattle should be fed daily. It is usually not profitable to feed more than 2 to 3 pounds daily of a commercial concentrate per 1,000 pounds liveweight of cattle, but when such roughages as those mentioned, which are very low in protein, are fed 3 pounds of linseed meal should be the minimum.

38. At the University of Illinois an experiment was conducted to ascertain the best method of preparing corn for feeding to fattening cattle. Four forms of corn were used, namely, corn meal, broken ear corn, corn and cob meal, and shelled corn. As a result of this experiment, it was found that the most profitable method of feeding corn is to feed it in the broken ear.

It is now believed by many successful cattle feeders and investigators that when corn is supplemented with 3 pounds of cottonseed meal or linseed meal and an abundance of good roughage, about a peck daily per 1,000 pounds liveweight of cattle is as much as it is safe to feed. If more than this quantity is fed there is danger of getting the animals off feed. Experienced feeders often feed more corn than this, but the novice should not feed much more than the quantity mentioned.

As a result of feeding trials in Texas it was found that 10 pounds of rice bran were equal to 16 pounds of cottonseed meal when forming two-fifths of the concentrate of the ration. Rice polish was found to be about equal to cottonseed meal.

It was found also that when cottonseed hulls were fed for roughage, $2\frac{3}{10}$ pounds of rough rice was equal to 1 pound of cottonseed meal.

In the sugar belt, molasses is very valuable feed as an appetizer. It is often claimed that molasses aids digestion. A common method of feeding molasses is to take a barrel spraying outfit, the barrel being filled with an equal volume of water and molasses, and drive through the feed lot spraying on the feed in the troughs such a quantity of the mixture as is to be fed.

39. In the long-feeding system of handling feeders it is desirable, for economy of gains, to have the cattle consume a large percentage of roughage during the early part of the feeding period. For this reason, many feeders start cattle on a long feed by allowing them to run in a stalk field, supplementing the roughage they obtain with from 4 to 6 pounds of ear corn per head per day. The corn ration is gradually increased until the cattle are on full feed. When cattle are pastured on stalk fields it is desirable that they have access to a straw stack. Under favorable conditions, stalk fields will not afford pasture much later than the middle of January, and it is seldom advisable to leave cattle on them until that time. As soon as the stalk pastures become depleted the cattle should either be removed or supplied with supplementary roughage.

When the stalk pastures fail it is a good plan to put the cattle in a dry lot provided with an open shed. The lot should be well drained so that the cattle will not be compelled to wade through mud. Enough coarse feeds should be fed to keep the animals thriving. Corn silage is one of the best feeds for this purpose. It can be advantageously supplemented with clover or alfalfa hay fed in limited quantities, or with a small quantity of cottonseed meal. Clover or alfalfa hay at the rate of about 2 pounds per steer per day with all the corn silage the steers will eat ought to carry them through the winter in good condition. It might be well also to add to this ration what oat straw or corn stover the cattle will readily consume. If clover or alfalfa hay is not available and corn silage is fed, corn stover and oat straw being depended on for additional roughage, it

will be found advisable to feed cottonseed meal at the rate of 1 pound daily per 1,000 pounds liveweight of cattle. In case clover or alfalfa hay is used as the principal roughage, it is a good plan to feed from 15 to 17 pounds daily per animal and supplement this with from 4 to 6 pounds of shelled corn or ear corn per 1,000 pounds liveweight of cattle. These rations should be increased considerably if the cattle are to be matured early the following summer. If, however, the aim is merely to carry the cattle through the winter in a thrifty condition, making the minimum gains, the ration suggested will be satisfactory.

40. In some sections of the country cattle feeders use nothing but shock corn—corn fodder—for the fattening of cattle. Shock corn is fed with the greatest profit in early fall, used either as the only constituent of the ration or as a supplement to other roughage such as standing corn stalks. The quantity of shock corn to feed depends on the quantity of grain that it is desired to feed. If shock corn is the only feed used, enough of it to furnish from 15 to 25 pounds of ear corn should be fed daily to a 1,200-pound steer. A better method of feeding shock corn is to feed enough to furnish from 8 to 10 pounds of ear corn and supplement this with broken, shelled, or crushed corn and from 2 to 3 pounds of cottonseed meal. The quantities just given are for animals on full feed. The disadvantages in feeding shock corn are that a large space is required to store the feed, unless the feeder chooses to haul it directly from the field to the feed lot, which is a disagreeable task in bad weather, and that it is not an economical method of utilizing a corn crop. For these reasons, the feeding of shock corn is not as extensively practiced as formerly, the feeding of the corn plant as silage being a much better method of fattening cattle.

Where plenty of pasture is available, feeders often purchase feeding cattle in the spring and allow them to graze during the pasture season. If the cattle are to be fattened during early fall and winter, there is no better feed after the pastures fail than corn cut before it is mature and fed directly to the animals. After the corn matures the cattle can be finished on any of the standard rations.

The rations previously given for the fattening of cattle on a short feed are suitable for cattle on a long feed that are receiving a full ration. Rations for the fattening of yearlings, 2-year-olds, and older cattle, are practically the same, yearlings possibly requiring a little larger proportion of protein than older cattle.

41. The method to use in getting cattle on full feed is a point about which there is considerable difference of opinion among feeders. One class of cattle feeders insist that the best results are secured by getting the cattle on full feed quickly. The most radical of this class recommend taking cattle from the market or pastures, that have not been accustomed to grain, and putting them on practically a full feed of corn within a week. Others recommend taking 2 weeks for the same purpose. Another class of cattle feeders believe that it is not advisable to put cattle on full feed so quickly, and this class recommends taking from 2 to 6 weeks to get cattle on full feed. Generally speaking, feeders that believe in getting cattle on full feed quickly believe also that it is the best practice to feed as much corn as the animals will consume. Feeders that believe in getting cattle on feed more slowly and rationally believe that the most economical and profitable returns come from stopping a little short of maximum rations. The practice to be advised is largely dependent on the length of the feeding period. If the feeding period is short, it is certainly good practice to get the cattle on full feed in a short time; if 5 to 6 months or more is available for the finishing process, it is advisable to use more time.

Cattle on feed should be fed regularly and in the same way each time. They should be kept quiet. Cattle soon learn to have confidence in a quiet attendant.

42. Marketing of Cattle for Beef.—Few cattle feeders have the advantage of large local livestock markets; consequently, stock must either be sold at small local markets or be shipped some distance to large central markets. In small local markets, the feeder must be a good judge of the market value of his produce; as there are few buyers in a local market,

he will not have the advantage of competition among buyers or the aid of reliable commission merchants. At some season of the year, local trade will be oversupplied and there will be no demand for some grades of meat; consequently, the local price on livestock will drop unless there is a demand for the meat elsewhere.

It is seldom that it will pay to ship less than a carload of cattle any great distance. Occasionally, it is possible for two or more feeders to combine and make up a carload of cattle, especially if the cattle are uniform in grade, breeding, and size.

The bulk of the sales made in a large market are made through the aid of commission merchants. A car may be loaded with stock and consigned to a reliable commission firm without the owner accompanying the shipment, if this is desired. The commission firm, on receiving the car, will unload the cattle, care for and sell them, and after deducting the commission, yardage, and freight charges remit the balance to the consignor. The commission charges range from 50 cents a head to $12 per car. The advantage of turning the selling of the stock over to commission merchants is that they are acquainted with the buyers, know the trend of the market, and are able to judge the time to sell and the value of the stock.

Buyers on the market are able to judge remarkably well regarding the feeding that cattle have received just before or during shipment. The shipper should, therefore, prepare his cattle to stand shipment rather than fill them with feed just before they are to be sold. Cattle that have been fed on such feeds as corn, linseed meal, silage, grass, clover, or alfalfa hay are apt to scour badly unless prepared for shipping. About 24 hours before shipment the grain ration should be reduced considerably and timothy hay substituted for the roughage part of the ration. It is advisable to feed corn-fattened cattle a liberal quantity of oats or bran before shipping them. Water should be withheld for at least 6 hours before shipment.

43. At most shipping points a car can be secured for shipping cattle by notifying the railroad authorities a day in advance. If the weather is warm the stock should be moved

slowly and quietly to the shipping point during the cool part of the day. It is a good plan to load the cattle so that they will make most of the trip during the night, provided the weather is warm; cattle probably ride quieter during the night than during the day. The car should be well bedded so that the cattle will arrive at the market in the best possible condition. Cattle can be shipped 75 miles direct to market or any distance not requiring over 12 hours en route without any special provision for feeding. In case cattle are to be fed en route, hay and corn should be provided before shipment. For short shipments, the ordinary stock car, which will hold from 16 to 22 mature cattle, is used. For long shipments, specially built stock cars that contain water troughs are used. The troughs can be filled en route, the cattle being allowed only a moderate quantity of water to keep them in good shipping condition. Sometimes beef animals are shipped long distances, requiring several days for shipping. In this case it is wise to unload them a short distance from the market, and feed them well so that they will be in good condition when they arrive at the market.

After arriving at the market, the cattle should be unloaded and allowed to feed normally. Abnormal feeding should be guarded against, because animals that become unduly full will be discriminated against by buyers. After the cattle have been allowed to feed normally they are ready to be sold. Cattle may be sold direct by the shipper, but it is better policy for the inexperienced feeder to trust the selling to commission men, who are better acquainted with conditions.

MISCELLANEOUS INFORMATION

FITTING OF CATTLE FOR EXHIBITION

44. A person cannot expect to be highly successful in the fitting of cattle for exhibition unless he has had practical experience in the handling of show animals. Methods of fitting animals vary, the method used depending on the individuality of the animal. The information given here covers only the

fundamental principles of fitting cattle for the show ring and is offered only for the purpose of saving the novice from mistakes that he would otherwise make.

Only animals of the best conformation, quality, and style should be selected for exhibition. For the calf classes, the calves are usually selected when from 3 weeks to 1 month old. A calf of this age that is robust, symmetrical, deep, and broad, and that has straight top and bottom lines and a mellow skin may, under proper care, be expected to develop into a prize-winning animal.

As size and weight are very important in the show ring, the greatest age possible within the limit of the class in which an animal is to show should be secured. If a calf is born on or after September 1, it can show in the calf class at any time the following year; it can show as a yearling at any time the next spring; and it can show as 2-year-old at any time the year following. Thus it will be seen that a calf may still be showing in the calf class when it is 15 months of age. Calves and yearlings are usually exhibited in one of two classes, namely, the senior class and the junior class. Calves dropped between September 1 and January 1, show in the senior class, and those dropped after January 1 show in the junior class.

45. A calf that has been selected as an exhibition animal should be allowed to remain with its dam until it is 2 or 3 weeks old. It should then be removed from the dam, being allowed at first to nurse three times a day and after a time but twice daily. The calf should be allowed to nurse the dam as long as possible and if it will take more milk than is furnished by the dam, a nurse cow should be used. The quantity of milk that the calf gets is more important than that the milk shall contain a high percentage of butter fat. At from 6 to 8 weeks of age, the calf should be started on a grain ration of equal parts of shelled corn, whole oats, and bran, with all the clean clover or alfalfa hay it will clean up.

During the summer the calf should run on pasture, but should not be exposed to severe storms. In winter, it should be housed and provided with a dry bed, plenty of good air,

and sunshine. During good weather, the calf should be allowed the run of a sheltered lot, and should always be supplied with good water.

In the spring the animal should be put on grass, at first for only a short time each day and later, as the nights become warm, it should be turned in the pasture at night and kept in a cool, well-ventilated stable during the heat of the day. In darkening the stables to protect the animal from flies, care should be taken not to interfere with ventilation. The grass will cool the system of the calf and this together with the exercise enforced by grazing will put it in good shape for the heavy feeding that is to follow.

46. When the animal is to be shown in the fall, it should be taken off the pasture before the middle of the summer. From this time to the time of the show much skill is required on the part of the feeder to put the necessary amount of flesh on the animal along with the quality, finish, and bloom necessary to make a prize winner.

Some succulent feed, such as corn silage or roots, should be given, but care must be taken not to give enough of this feed to detract from the quality of the flesh. The grain ration should consist of ground oats, corn, and bran with a little linseed meal. An excess of corn should be avoided, as it will cause an excess of fat and detract from the smoothness of finish. Good, bright clover or alfalfa hay forms the best roughage. A variety of feeds is advisable, and everything should be done to tempt the appetite, but sudden changes should be avoided. Care should be taken not to feed a sufficient quantity of roughage to make the animal paunchy. Ordinarily, in the feeding of cattle for show, they are fed three or four times a day and watered about twice and this should be done at the same time each day; regularity is very important. The appetite should be kept keen. The feed boxes should be constructed so that they can be removed and thoroughly cleaned, and they should be scalded occasionally. In case the animal goes off feed, all feeds should be withheld for a time, and then, if possible, it should be allowed a fill of grass.

The quantity of feed to give must be regulated by the appetite of the animal. The appetite is most easily maintained with a variety of feeds in the ration, and a little brown sugar is often used to advantage. Sugar is especially good to feed during the show season to keep an animal on feed. In making up rations for show animals, it should be remembered that corn is a heavy feed and should be fed sparingly.

The progress during the latter part of the feeding period depends largely on the contentment of the animal. It should have its fill of a suitable ration and then be allowed to lie down and ruminate. Rumination is best performed while the animal is lying down and is devoting all its energy to this one thing.

47. The stable should be kept well bedded with fresh, bright straw. The animal should be removed from the stall twice every day and all the droppings and wet straw removed and fresh straw put in. Plenty of fresh air should be provided, but the barn should be kept free from drafts. For fattening purposes, too much light is not desired in a barn, and for this reason it is well to tack burlap over some of the windows.

A calf should be familiarized with grooming at an early age, as grooming will keep the coat in good shape and get the animal used to being handled. The earlier it is made familiar with the halter the better. The calf should be tied in its stall and led out occasionally, and as the show approaches it should be trained to lead among other animals and to stand squarely on its feet, with head up, and to advance at the command of the attendant. The award of premiums may be much influenced by the behavior of the animal in the show ring. If it does not stand naturally in the ring the judge cannot estimate its merits.

The animal should be groomed once daily, a good bristle brush, a card, and a flannel cloth or chamois skin being used. If a harsh brush or a sharp steel comb is used, grooming may be more injurious than helpful. The grooming should commence some weeks before the show. If the animal is kept in a dark stable, a blanket is unnecessary except during the last few days. The coat is usually washed weekly with soft

water and a good toilet soap. Hand-washing is much better than washing by means of hose, although not nearly so rapid. The washing removes the dust from the hair, saving considerable grooming, and promotes healthy action of the pores of the skin, tending to make the hair more soft and pliable. Sufficient time should be allowed between the last washing and the time the animal will go into the show ring to allow for an accumulation of oil in the hair.

In fitting the horns, the dead outer covering should first be removed. This is done by first using a sharp, heavy rasp, following this up with a jack knife, and finishing with emery paper. Sweet oil and tripoli are smeared on the horns, which are then thoroughly polished with a woolen cloth and then with any good polishing powder and a chamois skin.

The hoofs should receive careful attention. They should be trimmed back at frequent intervals, and to prevent them from becoming too dry, the animal should be led through a clay puddle several times a day.

48. When cattle are to be transported to the show by rail, the feed should be more or less modified. The grain portion of the ration should be reduced and this reduction adhered to until the animal reaches the grounds. When at the show the animal should receive the same ration it was receiving at home.

There is practically no danger of getting a calf or yearling too fat, but this condition is common with 2-year-olds. A calf or yearling, however, may be made too fat to carry over successfully for showing another year.

If it is desired to show the animal another season, the grain should be reduced on returning from the show and succulent feed supplied in order to allow the system to cool out and to prevent premature finish. The reduction in the grain ration should continue until about April or May, after which the quantity of feed should be gradually increased, about one month being taken to get the animal back to the maximum quantity. Great care must be exercised in feeding animals that have been exhibited, as otherwise they may become worthless for show purposes.

CASTRATION OF CALVES

49. Calves may be castrated best between the ages of 1 and 3 months. If a calf is healthy and strong, the sooner the operation is performed the better, because the nearer a calf is to maturity the harder the operation will be and the greater will be the danger of complications. It is advisable, when possible, to castrate a calf before or after fly time.

The operation may be performed with the calf standing, or the calf may be thrown and securely held or tied. Although many breeders never take the precaution, it is well to wash the scrotum with diluted carbolic acid or some other good disinfectant before making an incision. The scrotum and testicles should be firmly grasped with the left hand, the testicles being forced to the lower part. An incision should then be made longitudinally in each half of the scrotum near the division and through the several coverings of the testicles; the incisions should be large enough to let the testicles be forced out. If the incisions are low on the scrotum they will allow the wound to drain. The membrane connected to the testicles should then be freed and the cords cut about 5 inches back from the testicles. There is some danger of hemorrhage in cutting the cord off, so that some operators prefer to scrape the cord in two or to bruise it off. After the operation is completed it is a good plan to apply a disinfectant. If for any reason pus gathers in the scrotum, it should be washed out and the scrotum disinfected. A 5-per-cent. solution of carbolic acid is a good disinfectant for this purpose.

The castration of a mature male is accomplished in much the same manner as that just described, although greater care should be exercised in the operation and in guarding against exposure after the operation is completed. Some operators prefer, when castrating a mature bull, to have the animal standing in a narrow stall and securely stanchioned with head drawn around to the side.

Spaying, which consists in removing the ovaries of a female, is a delicate operation, and unless a breeder is experienced in the work it is better to employ a veterinarian.

DEHORNING OF CATTLE

50. By dehorning is meant the removing of horns from cattle or the stopping of the growth of horns on calves by applying some chemical. Hornless cattle can be handled more economically than horned cattle; they require much less room in the feed lots and sheds; a considerably larger number can get up to a feed rack at the same time; and there is not as much danger of animals goring each other as in the case of horned cattle. Hornless cattle are always more quiet in the feed lot and hence make more rapid gains. In a lot of horned cattle the timid animals are kept away from their feed and chased around the feed yard.

Hornless feeders usually sell at from 10 to 25 cents per hundredweight higher than horned ones. Horned cattle always bruise one another more or less in shipping and as the bruises show up plainly on the dressed carcass, they are often discriminated against. A hide that has been punctured by a horn is reduced in value for tanning purposes.

The horns should not be removed from pure-bred cattle, as each breed has a style of horn peculiar to itself and the style and quality of the horn are very important in determining the value of the animal for breeding or show. The removal of the horns also detracts from the style of the head of an animal.

Perhaps the most desirable method of dehorning is by the use of caustic potash or caustic soda when a calf is very young. This substance comes in sticks about the size of a lead pencil and can be procured at any drug store. The operation should be performed as soon as the horn can be located by rubbing the hand over the head; usually the best time is when a calf is about 2 weeks old, although the horn can be destroyed when it is nearly an inch long. First, the hair is clipped from around the horn. One end of the stick of caustic potash is rolled in paper to protect the hand and the other end is dipped in water. The horn should then be rubbed thoroughly until the skin becomes inflamed and crumbles up. If the horn is not rubbed thoroughly, it may be only partly destroyed and continue to grow in a deformed manner.

After the chemical has been thoroughly applied, a brown scab will form over the horn, which will come off in about a month. In applying the caustic, care should be used to keep the dissolved caustic from running down over the animal's head, causing useless sores or getting into the eyes. This method of dehorning leaves the head resembling a natural poll and is preferred by many, as it gives little pain and does not endanger the life of the animal.

When not in use, the sticks of caustic potash should be kept in a tightly stoppered bottle to prevent them from absorbing water from the air. Patent dehorning solutions are no more efficient than caustic potash and are simply saturated solutions of caustic soda or potash.

If cattle are not dehorned when young and the horns are allowed to grow out to a considerable length, they can be removed by pincers and saws made for the purpose. Pincers do the job more quickly and cause less pain than a saw, but they cut the blood vessels smoother and consequently the bleeding does not stop so quickly as when a saw is used. In either case the horn must be cut off from $\frac{1}{8}$ to $\frac{1}{4}$ inch below the point where the skin and the horn grow together. Unless this is done the horn will continue to grow and give a deformed appearance to the head. When a saw is used, it is necessary to put the animal in a stanchion and tie the head firmly, but if pincers are used it is only necessary to tie the animal's head firmly to a solid post, the pincers doing the job so quickly that the animal has little chance to struggle and get loose.

If possible, the operation should be performed on a bright, pleasant day, when the cattle can be turned out after being dehorned. The best time to dehorn is in the fall after the flies have gone and before cold weather sets in. If the operation is performed during cold weather, it is likely to cause catarrh, which may give very serious trouble. If animals are dehorned in fly time the flies are very likely to blow the cavity and it may thus become filled with maggots. In this case the wound will not heal and will cause great agony to the animal.

If the horns are cut a little beneath the skin, as directed, there is little danger of serious bleeding. However, it is a good

plan to have some bandages and absorbent material on hand. Pine tar is a good dressing to place on the horn to help in healing as well as to keep out harmful insects and germs.

Cattle just dehorned should not be allowed to run around straw or hay stacks where chaff or other material might get into the cavity.

BRANDING OF CATTLE

51. Branding is practiced on the ranges, where there is danger of large droves of cattle owned by different persons becoming intermingled. Each fall the stock is corralled and the young calves are marked the same as their dams. The marking is done with a hot iron, which sears the skin; after this the mark is always carried. Each ranch owner adopts some letters or a monogram as a brand, and a brand is recognized as proof of ownership; individual owners usually adopt some particular part of the body on which to place their brand.

Other systems of marking are usually adopted for the marking of stock in smaller herds, where it is desirable to have the individuals marked to keep records of their breeding, age, etc. The two methods of marking in general use are by metal ear tags, which contain a number and the owner's mark, and by notching the ears. The objection to metal tags of any kind is that they are easily pulled out and lost. A permanent system of marking may be adopted by notching the ears, as explained in *Sheep Management*, Part 1. The only serious objection to notching the ears is that it disfigures the appearance of the animal, especially if a high-class show animal. Some breeders brand the hoof or horn, and still others use a tattoo marker.

REGISTERING OF CATTLE

52. The various breed associations will, on application, furnish blanks to any person desiring to register an animal. The owner must fill out these blanks, giving a description of the animal, its pedigree, etc. If the association finds that the animal is eligible to registry, the secretary will issue to the owner a certificate of registry. The expense of registering

stock varies with the age and breed of the animal, and whether the breeder is a member of the association or not. Different associations have different requirements in regard to the registering of stock and the recording of ownership, so that it would be well for any one desiring specific information on this subject to consult the secretary of the association.

INDEX

NOTE.—All items in this index refer first to the section (see the Preface) and then to the page of the section. Thus, "Adulterated milk, §46, p20," means that adulterated milk will be found on page 20 of section 46.

A

Aberdeen-Angus cattle, §48, pp5, 28.
Abnormal presentation, §26, p13.
  variations, §26, p27.
Abomasum, §25, p12.
Abortion, §26, p15.
  Contagious, §26, p16.
  Non-contagious, §26, p16.
Absorption of feed, §25, p17.
Acid fermentation of milk, §45, p32.
  -forming bacteria, §45, p32.
  test for cream, Mann's, §47, p48.
  -testing outfit, Farrington's, §47, p32.
  -testing outfit, Mann's, §47, p31.
Acidity in cream, Determination of, §47, p47.
Acquired character, §26, p21.
Adulterated milk, §46, p20.
Advanced registry, §26, p55.
Advertising of breeding stock, §51, p28.
Age at which to breed cows, §51, p8.
  of a dairy cow, Determination of, §43, p15.
Agitation of cream in the churn, §47, p51.
Albumin, §45, p6.
Alcoholic fermentation in milk, §45, p38.
Alfalfa hay, §50, p44.
Alkaline test for cream, Farrington's, §47, p48.
Angus cattle, Aberdeen-, §48, pp5, 28.
Application for transfer, §44, p25.
Arm, §48, p3.
Artificial impregnation, §26, p10.
  ripening of cream, §47, pp43, 44.
  selection, §26, p32.
Ash, §45, p7.
  in digestion, §25, p16.
  in feed, Functions of, §25, p9.
  in feeds, §25, p4.
Atavism, §26, p18.
Ayrshire cattle, §42, p19.
  milk, §45, p7.

B

Babcock test, §46, p13; §47, p40.
  test outfits, §47, p27.
Baby-beef cattle, §49, p47.
  -beef cattle, Management of, §51, p32.
  fat, §44, p18.
Back, §43, p3; §48, p3.
Bacteria, Acid-forming, §45, p32.
  Butyric-acid, §45, p36.
  by heat, Control of, §45, p26.
  by use of sanitary milk pail, Excluding §45, p18.
  from coat of cow, §45, p12.
  from dust of stable, §45, p17.
  Gas-forming, §45, p33.
  in milk, §45, p10.
  in milk, Control of, §45, p23.
  in milk, Pathogenic, §45, p39.
  in milk, Sources of, §45, p11.
  in milk, Tests of, §45, p40.
  in udders of cows, §45, p11.
  Lactic-acid, §45, p33.
  prevalent in dark stables, §45, p18.
Bacterial infection, Milker as a source of, §45, p22.
Balanced ration, Making up a, §25, p31.
  rations, §25, p29.
Bank barn of the Tennessee Experiment Station, §41, p71.
  or basement, barns, §41, p67.
Barn and paddock for a bull, §50, p13.
  Combined shed and storage, §50, p15.
  Elaborate beef-cattle, §50, p13.
  for 18 cows, Model, §41, p42.
  for 20 cows, One-story, §41, p37.
  for 20 cows, Rectangular, §41, p35.
  for 24 cows, §41, p39.
  for 46 cows, §41, p42.
  for 72 cows, Basement, §41, p69.

242—45

Barn for 76 cows, Round, §41, p61.
for 88 cows, Polygonal, §41, p64.
for 105 cows, Round, §41, p62.
Medium size, §50, p6.
of the Iowa Agricultural College, §41, p54.
of the South Dakota Agricultural College, §41, p52.
of the Tennessee Experiment Station, Bank, §41, p71.
of the University of Illinois, Round, §41, p58.
Rectangular basement, §41, p68.
Round dairy, §41, p57.
Wisconsin dairy, §41, p46.
Barns, §50, p1.
Basement, or bank, §41, p67.
Construction of dairy, §41, p8.
Dairy, §41, p1.
Equipment for dairy, §41, p19.
Examples of dairy, §41, p35.
Floors for dairy, §41, p14.
for 70 cows, Polygonal, §41, p65.
Foundations for dairy, §41, p8.
Location of, §50, p2.
Materials for construction of, §50, p3.
Polygonal, §41, p63.
Rectangular, §50, p6.
Roofs for dairy, §41, p13.
Round, §50, p4.
Sites for dairy, §41, p6.
Ventilation of dairy, §41, p15.
Walls for dairy, §41, p1.
Barrel, §43, p3; §48, p3.
Barrow, §26, p47.
Basement barn for 72 cows, §41, p69.
barn, Rectangular, §41, p68.
or bank, barns, §41, p67.
Beef and dual-purpose cattle, Equipment for, §50, p1.
and dual-purpose cattle, Feeds for, §50, p40.
and dual-purpose cattle, Management of, §51, p8.
and dual-purpose cattle, Parts of, §48, p4.
breeding cattle, Score card for, §49, p63.
breeding cows, Selection of, §51, p4.
breeding cows, Summer feeding of, §51, p16.
breeding cows, Winter feeding of, §51, p18.
breeds of cattle, §48, p9.
calves, Management of, §51, p25.
carcass, §49, p54.
carcass to live weight, Proportion of, §49, p59.
cattle, §48, p1; §49, p4.
cattle, Baby-, §49, p47.
-cattle barn, Elaborate, §50, p13.
cattle, Grades of, §49, p3.
cattle, Judging of, §49, p60.
cattle, Management of baby-, §51, p32.
cattle, Procedure in judging of, §49, p65.
Beef cattle, Score card for market, §49, p62.
cows from a herd, Eliminating of undesirable, §51, p21.
cuts, Wholesale, §49, p54.
Marketing of cattle for, §51, p41.
type of cattle, §48, p5.
type of Holstein-Friesian cattle, §42, p16.
Beet pulp, §50, p48.
Belly, §48, p3.
Belted cattle, Dutch, §42, p24.
Berkshire swine, Score card for, §26, p54.
Bile, §25, p14.
Birth, §26, p12.
Premature, §26, p15.
Bitter milk, §45, p38.
Bloom, Milk, §51, p32.
Boar, §26, p3.
Boilers in a dairy, Steam, §46, p42.
Bologna bulls, §49, pp3, 22, 27.
Bones, Pin, §48, p3.
Books, Flock, §26, p50.
Herd, §26, p50.
Record, §26, p50.
Stud, §26, p50.
Boric acid, §45, p26.
Boston milk regulations, §46, p24.
Bottles, Cleaning of milk, §45, p21.
Milk, §46, p36.
Boxes, Salt, §50, p36.
Branded cattle, §49, p49.
Branding of cattle, §51, p51.
Breast, §48, p3.
Breeding, §26, pp2, 10.
cattle, Marketing of, §51, p28.
Close, §26, p40.
cows during winter, Care of, §51, p21.
cows, Feeding of dual-purpose, §51, p19.
cows, Management of, §51, p8.
cows, Selection of beef, §51, p4.
cows, Selection of dual-purpose, §51, p5.
cows, Summer feeding of beef, §51, p16.
cows when on pasture, Care of, §51, p20.
cows, Winter feeding of beef, §51, p18.
Double-standard, §48, p16.
herd, Management of a, §51, p8.
In-and-in, §26, p39.
Incestuous, §26, p39.
Laws of, §26, p17.
Line, §26, p40.
of cows, §51, p10.
operations, §26, p32.
Principles of animal, §26, p1.
rack, or crate, §50, p35.
records, §26, p49; §43, pp23, 24.
Single-standard, §48, p16.
stock, Advertising of, §51, p28.
stock, Methods of selling, §51, p29.

Breeding stock, Shipping of, §51, p32.
the dairy cow, §44, p5.
to points, §26, p46.
true, §26, p39.
Breeds, Dairy, §42, p4.
Improvement of, §26, p46.
Miscellaneous dairy, §42, p24.
of cattle, Beef, §48, p9.
of cattle, Dual-purpose, §48, p43.
of dairy cattle, §42, p1.
Brisket, §48, p3.
Brown Swiss cattle, §42, p28; §48, pp7, 50.
Brushes, Scrubbing, §47, p31.
Buck, §26, p3.
Bull, §26, p3.
Barn and paddock for a, §50, p13.
Disinfecting a, §51, p25.
Feeding a, §44, p21.
Feeding a herd, §51, p23.
Handling of a herd, §51, p22.
Methods of handling a, §44, p19.
rings, §50, p36.
Selection of a herd, §51, p6.
Selection of dairy, §43, p17.
Use of a, §44, p21.
Use of a herd, §51, p24.
Bulls, Bologna, §49, pp3, 22, 27.
Choice, §49, pp3, 13, 20.
Feeder, §49, pp3, 28, 36.
Good, §49, pp3, 13, 20.
Management of dairy, §44, p19.
Medium, §49, pp3, 13, 20.
Bunk for a muddy lot, Feed, §50, p27.
Ten-sided feed, §50, p25.
Bunks, Rectangular feed, §50, p25.
Butcher stock cattle, §49, p12.
stock cattle, Grades of, §49, p3.
Butcher's ideal animal, §49, p69.
Butter, §45, p35.
color to cream, Addition of, §47, p52.
fat, §45, p5.
fat, Table of cost in four different states of producing 100 pounds of milk and 1 pound of, §46, p2.
ladles and packers, §47, p35.
making, Equipment for farm, §47, p3.
making, Farm, §47, p1.
-making operations, §47, p35.
Packing of, §47, p58.
printers, §47, p29.
Salting of, §47, p55.
Washing of, §47, p54.
workers, §47, p28.
Working of, §47, p57.
Buttermilk, §45, p35; §46, p33.
Babcock test of, §47, p42.
Butyric-acid bacteria, §45, p36.
Butyric fermentation, §45, p36.
By-product feeds, Commercial, §25, p23.

C

Calf production, Dairying for, §43, p20.
Calves, Care of cows while suckling, §51, p11.
Castration of, §51, p48.
Grades of veal, §49, p3.
Management of, §44, p16.
Management of beef, §51, p25.
Management of dual-purpose, §51, p27.
Veal, §49, pp3, 42.
Calving, §26, p12.
time, Care of cow at, §51, p11.
Canada, Milk standards of, §46, p32.
Canadian cattle, French, §42, p29.
Canners, Cutters and, §49, p22.
Good, §49, pp3, 22, 24.
Grades of, §49, p3.
Inferior, §49, pp3, 22, 24.
Medium, §49, pp3, 22, 24.
Cannon, §48, p3.
Cans and their care, Milk, §46, p33.
Cleaning of milk, §45, p21.
Filling of milk, §46, p34.
Washing of milk, §46, p35.
Capillary circulation of a dairy cow, §43, p8.
Caps, Milk-bottle, §46, p36.
Carbohydrates in feeds, §25, p6.
in feed, Functions of, §25, p10.
Carcass, Beef, §49, p54.
to live weight, Proportion of beef, §49, p59.
Card for beef-breeding cattle, Score, §49, p63.
for Berkshire swine, Score, §26, p54.
for dairy cow, Score, §43, p4.
for market beef cattle, Score, §49, p62.
for stockers and feeders, Score, §49, p64.
of the City of New York, Score, §46, pp26–30.
Score, §26, p53.
Cards, Use of score, §43, p1; §49, p61.
Carriers, Feed, §41, p30.
Manure, §41, p31.
Milk, §41, p33.
Carrying devices, §41, p30.
Casein, §45, p6.
Castration, §26, p46.
of calves, §51, p48.
Cattle, Aberdeen-Angus, §48, p28.
Ayrshire, §42, p19.
Baby-beef, §49, p47.
Beef, §48, p1; §49, p4.
Beef breeds of, §48, p9.
Beef type of, §48, p5.
Branded, §49, p49.
Branding of, §51, p51.
Breeds of dairy, §42, p1.
Brown Swiss, §42, p28; §48, pp7, 50.

Cattle, Butcher stock, §49, p12.
Dakota-Texan, §49, p49.
Dehorning of, §51, p49.
Devon, §42, p30; §48, pp7, 43.
Dressed-beef, §49, pp51, 53.
Dual-purpose, §48, p1.
Dual-purpose breeds of, §48, p43.
Dual-purpose type of, §48, p7.
Dutch Belted, §42, p24.
Effect on profits of feed and care of, §46, p3.
Equipment for beef and dual-purpose, §50, p1.
Export, §49, p51.
Feeds for beef and dual-purpose, §50, p40.
for beef, Marketing of, §51, p41.
for exhibition, Fitting of, §51, p43.
for market, Management of, §51, p32.
French Canadian, §42, p29.
Galloway, §48, pp5, 35.
General-purpose, §48, p1.
General quality of, §49, p30.
Gestation table for, §44, p11; §51, p12.
Grades of beef, §49, p3.
Grades of butcher stock, §49, p3.
Guernsey, §42, p8.
Handling quality of, §49, p31.
Hereford, §48, pp5, 20.
Holstein-Friesian, §42, p13.
Jersey, §42, p4.
Judging of beef, §49, p60.
Judging of dual-purpose, §49, p69.
Management of baby-beef, §51, p32.
Management of beef and dual-purpose, §51, p8.
Market classes of, §49, p1.
Marketing of breeding, §51, p28.
Montana-Texan, §49, p49.
Parts of beef and dual-purpose, §48, p4.
Polled Durham, §48, pp5, 16.
Polled Hereford, §48, p20.
Procedure in judging of beef, §49, p65.
Red Polled, §42, p32; §48, pp7, 46.
Registering of, §51, p51.
Registration of dairy, §44, p22.
Score card for beef breeding, §49, p63.
Score card for market beef, §49, p62.
Selection of dairy, §43, p1.
Shipping, §49, pp51, 52.
Shipping of pure-bred, §43, p28.
Simmenthal, §42, p29.
Shorthorn, §42, p32; §48, pp5, 7, 9, 52.
Still, §49, p47.
Texas and Western range, §49, pp47, 49.
Sussex, §48, pp5, 40.
Wyoming-Texan, §49, p49.
Caves as butter-making quarters, §47, p5.
Cell-body, §26, p4.
Cell-wall, §26, p4.
Cellars as butter-making quarters, §47, p5.
Cells, Female germ, §26, p5.
Germ, §26, p4.
Male germ, §26, p5.
Centrifugal separation, §47, pp8, 35.
-separator mechanism, §47, p10.
separators, §47, p8.
separators, Types of, §47, p11.
Certificate of registry, §44, p24.
Certified milk, §46, pp31, 32.
Cheese, Cottage, §45, p36.
Chest, §43, p3.
capacity of dairy cows, §43, p3.
Chicago milk regulations, §46, p24.
Chime, §43, p3.
Churn, Agitation of cream in the, §47, p51.
Preparation of, §47, p52.
Quantity of cream in the, §47, p51.
Washing of, §47, p55.
Churning, §47, p49.
equipment, Miscellaneous, §47, p24.
Operations of, §47, p52.
Power outfits for, §47, p24.
Richness of cream for, §47, p50.
Ripeness of cream for, §47, p51.
Size of fat globules in cream for, §47, p51.
Straining of cream for, §47, p52.
Temperature of cream for, §47, p49.
Time to stop, §47, p54.
Churns, §47, p19.
Dash, §47, p20.
Operation of, §47, p53.
Revolving, §47, p21.
Swinging, §47, p24.
Circulation of a dairy cow, Capillary, §43, p8.
Circulatory system of a dairy cow, §43, p6.
Cistern, Milk, §45, p2.
Clarification of milk, §45, p23.
Classes of cattle, Market, §49, p1.
Claws, Dew, §48, p3.
Cleaners for cows, Vacuum, §45, p15.
Cleaning of cream separators, §45, p22.
of milk bottles, §45, p21.
of milk cans, §45, p21.
Cleanliness as a means of control of bacteria in milk, §45, p23.
of utensils, §45, p19.
Clipping of cows, §45, p17.
Close breeding, §26, p40.
Clotted cream, §46, p33.
Clover hay, §50, p44.
Cod, §26, p9; §48, p3.
Colored milks, §45, p39.
Colostrum, §45, pp3, 15.
Complex-bowl separators, §47, p13.
Compound, Definition of, §25, p3.

Concentrated feeds, §50, p40.
Concentrates, §25, p22.
Condensed cream, §46, p33.
milk, §45, p32; §46, p33.
skim milk, §46, p33.
Conformation, §48, p3.
Dairy, §42, p1.
to milk secretion, Relation of dairy, §42, p2.
Constitution, §26, p36.
Contamination of milk, §45, p10.
Cooler, Milk, §45, p25.
Cooling and storing of milk, §45, p24.
Copulation, §26, p10.
Cord, §43, p14.
Corn, §50, p40.
stover, §50, p47.
Cottage cheese, §45, p36.
Cottonseed hulls, §50, p47.
meal, §50, p42.
Covering, §26, p10.
Cow, §26, p3.
at calving time, Care of, §51, p11.
Bacteria from coat of, §45, p12.
Breeding the dairy, §44, p5.
Care of a pregnant, §44, p7.
Circulatory system of a dairy, §43, p6.
Determination of age of a dairy, §43, p15.
Digestive system of a dairy, §43, p8.
during parturition, Care of a, §44, p10.
Feeding the dairy, §44, p1.
milk, §45, p5.
Milk signs in a dairy, §43, p12.
Score card for dairy, §43, p4.
Temperament of a dairy, §43, p9.
Udder development of a dairy, §43, p10.
Cowpea hay, §50, p45.
Cow's udder, Structure of a, §45, p2.
Cows, Age at which to breed, §51, p8.
Bacteria in udders of, §45, p11.
Breeding of, §51, p10.
Choice, §49, pp3, 13, 18.
Clipping of, §45, p17.
during winter, Care of breeding, §51, p21.
Feeding of dual-purpose breeding, §51, p19.
from a herd, Eliminating of undesirable beef, §51, p21.
from a herd, Eliminating of undesirable dual-purpose, §51, p22.
Good, §49, pp3, 13, 18.
Management of breeding, §51, p8.
Management of dairy, §44, p1.
Medium, §49, pp3, 13, 18.
Parturition in, §51, p11.
Period of gestation in, §51, p10.
Period of heat in, §51, p8.
Prime, §49, pp3, 13, 18.
Quantity of milk produced by, §46, p2.
Cows, Rations for dairy, §44, p3.
Season at which to breed, §51, p9.
Selection of beef-breeding, §51, p4.
Selection of dairy, §43, p1.
Selection of dual-purpose breeding, §51, p5.
Seven-day milk record for twenty, §46, p9.
Signs of pregnancy in, §51, p10.
Summer feeding of beef-breeding, §51, p16.
Vacuum cleaners for, §45, p15.
when on pasture, Care of breeding, §51, p20.
while suckling calves, Care of, §51, p11.
Winter feeding of beef-breeding, §51, p18.
Crate, Breeding rack, or, §50, p35.
Cream, §45, p6; §46, p33.
Addition of butter color to, §47, p52.
Artificial ripening of, §47, pp43, 44.
Babcock test of, §47, p40.
Clotted, §46, p33.
Condensed, §46, p33.
Conditions affecting churnability of, §47, p49.
Determination of acidity in, §47, p47.
Evaporated, §46, p33.
Farrington's alkaline test for, §47, p48.
for churning, Richness of, §47, p50.
for churning, Ripeness of, §47, p51.
for churning, Size of fat globules in, §47, p51.
for churning, Straining of, §47, p52.
for churning, Temperature of, §47, p49.
in the churn, Agitation of, §47, p51.
in the churn, Quantity of, §47, p51.
Mann's acid test for, §47, p48.
Natural ripening of, §47, p43.
Ripening of, §47, p43.
-separating equipment, §47, p8.
Separation of, §47, p35.
separators, Cleaning of, §45, p22.
standards, Table of state milk and, §46, p18.
strainers, stirrers, and samplers, §47, p33.
Creaming of milk, §45, p6.
Crops, §48, p3.
Root, §25, p28.
Soiling, §25, p27.
Cross-breed, §26, p38.
Crossing, §26, p41.
Curdling of milk, Sweet, §45, p36.
Curd test of milk, Wisconsin, §45, p43.
Cuts, Wholesale beef, §49, p54.
Cutters and canners, §49, p22.
Common, §49, pp3, 22, 24.
Good, §49, pp3, 22, 24.
Grades of, §49, p3.
Medium, §49, pp3, 22, 24.

D

Dairy barn, Round, §41, p57.
barn, Wisconsin, §41, p46.
barns, §41, p1.

Dairy barns, Construction of, §41, p8.
barns, Equipment for, §41, p19.
barns, Examples of, §41, p35.
barns, Floors for, §41, p14.
barns, Foundations for, §41, p8.
barns, Roofs for, §41, p13.
barns, Sites for, §41, p6.
barns, Ventilation of, §41, p15.
barns, Walls for, §41, p10.
breeds, §42, p4.
breeds, Miscellaneous, §42, p24.
bull, Selection of, §43, p17.
bulls, Management of, §44, p19.
cattle, Breeds of, §42, p1.
cattle, Registration of, §44, p22.
cattle, Selection of, §43, p1.
conformation, §42, p1.
conformation to milk secretion, Relation of, §42, p2.
cow, Breeding the, §44, p5.
cow, Circulatory system of a, §43, p6.
cow, Digestive system of a, §43, p8.
cow, Determination of age of a, §43, p15.
cow, Feeding the, §44, p1.
cow, Milk signs in a, §43, p12.
cow, Score card for, §43, p4.
cow, Temperament of a, §43, p9.
cow, Udder development of a, §43, p10.
cows, Management of, §44, p1.
cows, Rations for, §44, p3.
cows, Selection of, §43, p1.
herds, Management of, §44, p1.
Steam boilers in a, §46, p42.
thermometers, §47, p31.
type, Description of, §42, p1.
Dairying for calf production, §43, p20.
for milk production, §43, p19.
Systems of, §43, p19.
Dakota Agricultural College, Barn of the South, §41, p52.
-Texan cattle, §49, p49.
Dam, §26, p3.
Dash churns, §47, p20.
Deep-setting separation, §47, pp15, 38.
-setting separation, Devices for, §47, p16.
Dehorning of cattle, §51, p49.
shears, §50, p35.
Devon cattle, §42, p30; §48, pp7, 43.
Dew claws, §48, p3.
Dewlap, §43, p3; §48, p3.
Digestibility of feed, Factors influencing, §25, p18.
Digestion, Ash in, §25, p16.
of feed, §25, p11.
Water in, §25, p16.
Digestive changes in the intestines, §25, p14.
changes in the mouth, §25, p11.
Digestive changes in the stomach, §25, p11.
system of a dairy cow, §43, p8.
Dipping tank, §50, p37.
Direct heredity, §26, p17.
Discontinuous variations, §26, p27.
Disease, Inheritance of, §26, p19.
Diseases transmitted by milk, §45, pp39, 40.
Disinfecting a bull, §51, p25.
Distillers, §49, p47.
Doe, §26, p3.
Domestic animals, §26, p2.
Dominant character, §26, p24.
Double-standard breeding, §48, p16.
Dressed-beef cattle, §49, pp51, 53.
Dual-purpose breeding cows, Feeding of, §51, p19.
-purpose breeding cows, Selection of, §51, p5.
-purpose breeds of cattle, §48, p43.
-purpose calves, Management of, §51, p27.
-purpose cattle, §48, p1.
-purpose cattle, Equipment for beef and, §50, p1.
-purpose cattle, Feeds for beef and, §50, p40.
-purpose cattle, Judging of, §49, p69.
-purpose cattle, Management of beef and, §51, p8.
-purpose cattle, Parts of beef and, §48, p4.
-purpose cows from a herd, Eliminating of undesirable, §51, p22.
-purpose type of cattle, §48, p7.
Ducts, Milk, §45, p2.
Durham cattle, Polled, §48, pp5, 16.
Dust of stable, Bacteria from, §45, p17.
Dutch Belted cattle, §42, p24.

E

Early maturity, §48, p4.
Elbow, §48, p3.
Electric milking machines, §46, p6.
Element, Definition of, §25, p3.
Embryo, Development of the, §26, p11.
Embryotome, §26, p14.
Energy, Production of, §25, p7.
Equipment, Cream-separating, §47, p8.
for beef and dual-purpose cattle, §50, p1.
for dairy barns, §41, p19.
for farm butter making, §47, p3.
Miscellaneous churning, §47, p24.
Escutcheon, §43, pp3, 13.
Evaporated cream, §46, p33.
milk, §45, p32; §46, p33.
Ewe, §26, p3.
milk, §45, p5; §46, p33.
Excellence, Standard of, §26, p53.
Exhibition, Feeding of cattle for, §51, p43.
Export cattle, §49, p51.
Extra teats, §43, p14.

F

Face, §43, p3; §48, p3.
Fallopian tubes, §26, p8.
  tubes, Pavilion of the, §26, p9.
Farm butter making, §47, p1.
  butter making, Equipment for, §47, p3.
Farrington's acid-testing outfit, §47, p32.
  alkaline test for cream, §47, p48.
Farrowing, §26, p12.
Fat, Baby, §44, p18.
  Butter, §45, p5.
  globules in cream for churning, Size of, §47, p51.
  in feed, Functions of, §25, p10.
  in feeds, §25, p7.
  Milk, §45, p5.
  Table of cost in four different states of producing 100 pounds of milk and 1 pound of butter, §46, p2.
  Tongue, §48, p3.
Feces, §25, p16.
Fecundity, §26, p37.
Fed westerns, §49, p49.
Feed, Absorption of, §25, p17.
  and care of cattle, Effect on profits of, §46, p3.
  bunk for a muddy lot, §50, p27.
  bunk, Ten-sided, §50, p25.
  bunks, Rectangular, §50, p25.
  carriers, §41, p30.
  compounds, Functions of, §25, p8.
  Cost or availability of, §25, p37.
  Digestion of, §25, p11.
  Expulsion of undigested part of, §25, p16.
  Factors influencing digestibility of, §25, p18.
  Functions of, §25, p7.
  Functions of ash in, §25, p9.
  Functions of carbohydrates in, §25, p10.
  Functions of fat in, §25, p10.
  Functions of protein in, §25, p9.
  Functions of water in, §25, p8.
  lots at the Illinois Experiment Station, Shed and, §50, p19.
  lots at the Missouri Experiment Station, Shed and, §50, p16.
  on animals, Physiological effects of, §25, p36.
  on milk composition, Influence of, §45, p9.
  Palatability of, §25, p20.
  Preparation of, §25, p20.
Feeder bulls, §49, pp3, 28, 36.
Feeder's ideal animal, §49, p68.
  wattle, §48, p3.
Feeders, Choice, §49, pp3, 28, 29.
  Common, §49, pp3, 28, 36.
  Fancy selected, §49, pp3, 28, 29.
  Good, §49, pp3, 28, 32.
  Grades of, §49, p3.
Feeders, Inferior, §49, pp3, 28, 36.
  Management of, §51, p34.
  Medium, §49, pp3, 28, 32.
  Score card for stockers and, §49, p64.
  Stockers and, §49, pp3, 27.
Feeding a bull, §44, p21.
  a herd bull, §51, p23.
  Frequency of, §25, p21.
  Long, §51, p35.
  of baby-beef cattle, §51, p33.
  of beef-breeding cows, Summer, §51, p16.
  of beef-breeding cows, Winter, §51, p18.
  of dual-purpose breeding cows, §51, p19.
  of feeders, §51, p37.
  Principles of animal, §25, p1.
  Short, §51, p34.
  standards, §25, p29.
  standards, Table of Wolff-Lehmann, §25, p62.
  the dairy cow, §44, p1.
Feeds, Ash in, §25, p4.
  by horses and sheep, Table of comparison of the digestibility of, §25, p19.
  Carbohydrates in, §25, p6.
  Classification of, §25, p22.
  Commercial by-product, §25, p23.
  Composition of, §25, p3.
  Concentrated, §50, p40.
  Fat in, §25, p7.
  for beef and dual-purpose cattle, §50, p40.
  Miscellaneous factors affecting the selection and use of, §25, p34.
  Protein in, §25, p5.
  Roughage, §50, p44.
  Selection and use of, §25, p29.
  Succulent, §50, p47.
  Supplemental, §25, p23.
  Water in, §25, p4.
Feedstuffs, Table of average composition of American, §25, p38.
  Table of total dry matter and total digestible nutrients in 100 pounds of American, §25, p52.
Female germ cells, §26, p5.
  reproductive organs, §26, p6.
Fences, §50, p29.
Fermentation, Butyric, §45, p36.
  in milk, Alcoholic, §45, p38.
  of milk, §45, p10.
  of milk, Acid, §45, p32.
  test of milk, §45, p42.
Fermentations, Milk, §45, p32.
Fertilization, §26, p9.
Fetus, §26, p11.
Filling of milk cans, §46, p34.
  utensils, Milk, §46, p36.
Filly, §26, p3.
Fitting of cattle for exhibition, §51, p43.

Fixed types, §26, p26.
Flank, §43, p3.
Fore, §48, p3.
Hind, §48, p3.
vein, §43, p14.
Flaxseed meal, §50, p43.
Flock books, §26, p50.
Flooring materials, §50, p4.
Floors for dairy barns, §41, p14.
Fluids, Secretion of, §25, p8.
Foaling, §26, p12.
Fodders, §25, p26.
Follicles, §45, p2.
Forceps, Lamb and pig, §26, p15
Fore flank, §43, p3; §48, p3.
ribs, §48, p3.
Forehead, §43, p3.
Form, §48, p3.
Formaldehyde, §45, p26.
Foundation stock, Selection of, §51, p2.
Foundations for dairy barns, §41, p8.
Founding of a herd, §51, p1.
French Canadian cattle, §42, p29.
Friesian cattle, Holstein-, §42, p13.

G

Galloway cattle, §48, pp5, 35.
Gas-forming bacteria, §45, p33.
milking machines, §46, p6.
Gaskins, §48, p3.
Gastric juice, §25, p13.
Gate, Pinch, §50, p30.
Gelding, §26, p47.
General-purpose cattle, §48, p1.
Genital organs, §26, p6.
Germ cells, §26, p4.
cells, Female, §26, p5.
cells, Male, §26, p5.
Gestation in cows, Period of, §51, p10.
Period of, §26, p11.
table for cattle, §44, p11; §51, p12.
tables, §26, p11.
Gilt, §26, p3.
Goat milk, Nanny, §45, p5.
Goat's milk, §46, p33.
Government milk standards, §46, p17.
Grade, §26, p38.
Grass westerns, §49, p49.
Gravity separation, §47, p37.
separation, Devices for, §47, p15.
Guaranteed milk, §46, p31.
Guernsey cattle, §42, p8.
milk, §45, p7.

H

Handling quality of cattle, §49, p31.
Harking back, §26, p18.
Hay, Alfalfa, §50, p44.
Hay, Clover, §50, p44.
Cowpea, §50, p45.
Oat-and-pea, §50, p46.
Prairie, §50, p46.
Soybean, §50, p44.
Timothy, §50, p45.
Hays, §25, p25.
Head, Tail, §48, p3.
Heat, §26, p10.
Control of bacteria by, §45, p26.
in cows, Period of, §51, p8.
Heifer, §26, p3.
Heifers, Choice, §49, pp3, 13, 15.
Common stock, §49, pp3, 28, 40.
Good, §49, pp3, 13, 15.
Good stock, §49, pp3, 28, 40.
Medium, §49, pp3, 13, 15.
Medium stock, §49, pp3, 28, 40.
Prime, §49, pp3, 13, 15.
Herd, Advertising the, §43, p25.
books, §26, p50.
bull, Feeding a, §51, p23.
bull, Handling of a, §51, p22.
bull, Selection of a, §51, p6.
bull, Use of a, §51, p24.
Eliminating of undesirable beef cows from a, §51, p21.
Eliminating of undesirable dual-purpose cows from a, §51, p22.
Founding of a, §51, p1.
Management of a breeding, §51, p8.
Herds, Management of dairy, §44, p1.
Heredity, Direct, §26, p17.
Indirect, §26, p18.
Law of, §26, p17.
Hereford cattle, §48, pp5, 20.
cattle, Polled, §48, p20.
Hind flank, §48, p3.
Hips, §43, p3.
Hocks, §48, p3.
Hollow-bowl separators, §47, p11.
Holstein-Friesian cattle, §42, p13.
milk, §45, p7.
Honeycomb, §25, p12.
Hooks, §48, p3.
Horse, Stomach of a, §25, p14.
Hulls, Cottonseed, §50, p47.
Hybrid, §26, p38.
Hybrids, Mendel's law of, §26, p22.
Hydrochloric acid, §25, p13.

I

Ideal animal, Butcher's, §49, p69.
animal, Feeder's, §49, p68.
stall, New, §45, p14.
Illinois Experiment Station, Shed and feed lots at the, §50, p19.

Illinois, Round barn of the University of, §41, p58.
Impotent, §26, p6.
Impregnation, §26, p10.
  Artificial, §26, p10.
In-and-in breeding, §26, p39.
Inbreeding, §26, p39.
Incestuous breeding, §26, p39.
Indirect heredity, §26, p18.
Individual merit, §26, p32.
Inheritance, Law of, §26, p17.
  of acquired characters, §26, p21.
  of disease, §26, p19.
  of malformations and mutilations, §26, p20.
Intestinal juice, §25, p16.
Intestines, Digestive changes in the, §25, p14.
Intra-uterine, or prenatal, influences, §26, p31.
Iowa Agricultural College, Barn of the, §41, p54.

J

Jack, §26, p3.
Jenny, §26, p3.
Jersey cattle, §42, p4.
  milk, §45, p7.
Judging, §26, p53.
  of beef cattle, §49, p60.
  of beef cattle, Procedure in, §49, p65.
  of dual-purpose cattle, §49, p69.

K

Kefir, §45, p38.
King system of ventilation, §41, p16.
Knee, §48, p3.
Koumiss, §45, p38.

L

Labor, §26, p13.
Lactic-acid bacteria, §45, p33.
Lactose, §45, p6.
Ladles, Butter, §47, p35.
Lamb and pig forceps, §26, p15.
Lambing, §26, p12.
Laws of the State of New York, Milk, §46, p20.
  of the State of Wisconsin, Milk, §46, p21.
Line breeding, §26, p40.
Linseed meal, §50, p43.
Live weight, Proportion of beef carcass to, §49, p59.
Loin, §43, p3; §48, p3.
Long feeding, §51, p35.

M

Machines, Milking, §46, p5.
Male germ cells, §26, p5.
  reproductive organs, §26, p9.
Malformations, §26, pp20, 27.
Mammals, §26, p3.
Mangers, §41, p28.
Mann's acid test for cream, §47, p48.
  acid-testing outfit, §47, p31.
Manure carriers, §41 p31.
Manyplies, §25, p12.
Mare, §26, p3.
  milk, §45, p5.
Market beef cattle, Score card for, §49, p62.
  classes of cattle, §49, p1.
  Management of cattle for, §51, p32.
  milk, §46, pp1, 30.
  milk, Handling of, §46, p33.
Marketing of breeding cattle, §51, p28.
  of cattle for beef, §51, p41.
Mating, §26, p38.
Maturity, Early, §48, p4.
Meal, Cottonseed, §50, p42.
  Linseed, §50, p43.
  Oil, §50, p43.
Mendel's law of hybrids, §26, p22.
Merit, Individual, §26, p32.
  Register of, §42, p8.
Midribs, §48, p3.
Milk, §45, p1; §46, p32.
  Absorption of odors by, §45, p44.
  Acid fermentation of, §45, p32.
  Adulterated, §46, p20.
  Alcoholic fermentation in, §45, p38.
  -and-beef type of Holstein-Friesian cattle, §42, p16.
  and cream standards, Table of state, §46, p18.
  and 1 pound of butter fat, Table of cost in four different states of producing 100 pounds of, §46, p2.
  Ayrshire, §45, p7.
  Babcock test of skim-, §47, p41.
  Bacteria in, §45, p10.
  Bitter, §45, p38.
  bloom, §51, p32.
  bottles, caps, and filling utensils, §46, p36.
  bottles, Cleaning of, §45, p21.
  cans and their care, §46, p33.
  cans, Cleaning of, §45, p21.
  cans, Filling of, §46, p34.
  cans, Washing of, §46, p35.
  carriers, §41, p33.
  Certified, §46, pp31, 32.
  cistern, §45, p2.
  Clarification of, §45, p23.
  Composite sample of, §46, p11.
  Composition of, §45, p3.
  composition, Factors influencing, §45, p7.
  composition, Influence of breed on, §45, p7.
  composition, Influence of feed on, §45, p9.
  composition, Influence of stage of milking on, §45, p8.
  composition, Influence of time of milking on, §45, p8.

Milk, Condensed, §45, p32, §46, p33.
Condensed skim-, §46, p33.
constituents, §45, p3.
Contamination of, §45, p10.
Control of bacteria in, §45, p23.
cooler, §45, p25.
Cooling and storing of, §45, p24.
Cost of producing, §46, p1.
Cow, §45, p5.
Creaming of, §45, p6.
Diseases transmitted by, §45, pp39, 40.
ducts, §45, p2.
Evaporated, §45, p32; §46, p33.
Ewe, §45, p5; §46, p33.
fat, §45, p5.
Fermentation of, §45, p10.
Fermentation test of, §45, p42.
fermentations, §45, p32.
Goat's, §46, p33.
Guaranteed, §46, p31.
Guernsey, §45, p7.
Handling of market, §46, p33.
Holstein, §45, p7.
Jersey, §45, p7.
laws of the State of New York, §46, p20.
laws of the State of Wisconsin, §46, p21.
Mare, §45, p5.
Market, §46, pp1, 30.
Nanny goat, §45, p5.
of different species of animals, Table of composition of, §45, p5.
pail, Excluding bacteria by use of sanitary, §45, p18.
Pasteurized, §46, pp31, 32.
Pathogenic bacteria in, §45, p39.
powder, §45, p32.
Preserved, §45, p32.
produced by cows, Quantity of, §46, p2.
production, Dairying for, §43, p19.
production, Profits in, §46, p1.
record for twenty cows, Seven day, §46, p9.
regulations, City, §46, p23.
Ropy, §45, p37.
Secretion of, §45, p1.
secretion, Relation of dairy conformation to, §42, p2.
secretion, Time of, §45, p3.
Selected, §46, p30.
Shorthorn, §45, p7.
signs in a dairy cow, §43, p12.
Skim-, §46, p32.
Sources of bacteria in, §45, p11.
Standards for, §46, p17.
standards of Canada, §46, p32.
standards of the United States, §46, p17.
standards, State, §46, p19.
Sterilized, §46, p32.
Milk, Straining of, §45, p23.
sugar, §45, p6.
Sweet curdling of, §45, p36.
type of Holstein-Friesian cattle, §42, p16.
Use of preservatives in, §45, p26.
veins, §43, p3.
Weighing, testing, and keeping of records of, §46, p8.
wells, §43, p6.
Wisconsin curd test of, §45, p43.
Milker as a source of bacterial infection, §45, p22.
Milkers and springers, §49, pp3, 46.
Grades of, §49, p3.
Milking, Effect on profits of method of, §46, p4.
machines, §46, p5.
Milks, Colored, §45, p39.
Millet, §50, p46.
Missouri Experiment Station, Shed and feed lots at the, §50, p16.
Mixed milk, §45, p1.
Model barn for 18 cows, §41, p42.
stall, §41, p23; §45, p13.
Monstrosities, §26, p28.
Montana-Texan cattle, §49, p49.
Mouth, Digestive changes in the, §25, p11.
Muddy lot, Feed bunk for a, §50, p27.
Mutilations, §26, p20.
Muzzle, §43, p3; §48, p3.

N

Nanny, §26, p3.
goat milk, §45, p5.
Native, §26, p38.
Natural ripening of cream, §47, p43.
selection, §26, p32.
Navel, §43, p3.
Neck, §43, p3; §48, p3.
New Ideal stall, §41, p25; §45, p14.
York City milk regulations, §46, p23.
York, Milk laws of the state of, §46, p20.
York, Score card of the city of, §46, pp26–30.
Normal presentation, §26, p13.
variations, §26, p26.
Nucleolus, §26, p4.
Nucleus, §26, p4.
Nutritive ratio, §25, p30.

O

Oat-and-pea hay, §50, p46.
Oats, §50, p42.
Odors by milk, Absorption of, §45, p44.
Œstrum, §26, p10.
Oil meal, §50, p43.
Omasum, §25, p12.
One-story barn for 20 cows, §41, p37.
Organs, Female reproductive, §26, p6.

Organs, Genital, §26, p6.
Male reproductive, §26, p9.
of milk secretion, §45, p1.
Reproductive, §26, p6.
Os uteri, §26, p8.
Ovaries, §26, pp5, 8, 9.
Ovulation, §26, p10.
Ovum, §26, p5.
Ox, Stomach of an, §25, p12.

P

Packers, Butter, §47, p35.
Packing of butter, §47, p58.
Paddock for a bull, Barn and, §50, p13.
Pail, Excluding bacteria by use of sanitary milk, §45, p18.
Palatability, §25, p34.
of feed, §25, p20.
Pancreatic juice, §25, p15.
Parturition, §26, p12.
Care of cow during, §44, p10.
in cows, §51, p11.
Pasteurization, §45, p27.
Pasteurized milk, §46, pp31, 32.
Pasteurizing outfits, §47, p27.
Pasture, Care of breeding cows when on, §51, p20.
Pastures, Convenience of site of dairy barn to, §41, p8.
Pathogenic bacteria in milk, §45, p39.
Paunch, §25, p12.
Pavilion of the Fallopian tubes, §26, p9.
Pea hay, Oats-and-, §50, p46.
Pedigree, §26, pp50, 51.
Pelvic arch, §43, p13.
Penis, §26, p9.
Pepsin, §25, p13.
Peptone, §25, p13.
Pig forceps, Lamb and, §26, p15.
Pin bones, §43, p3; §48, p3.
Pinch gate, §50, p30.
Point, Shoulder, §48, p3.
Points, §26, p46.
Standard scale of, §26, p53.
Poll, §43, p3; §48, p3.
Polygonal barns, §41, p63.
Polled cattle, Red, §42, p32; §48, p46.
Durham cattle, §48, pp5, 16.
Hereford cattle, §48, p26.
Polygonal barn for 88 cows, §41, p64.
barns for 70 cows, §41, p65.
Powder, Milk, §45, p32.
Power outfits for churning, §47, p24.
Prairie hay, §40, p46.
Pregnancy in cows, Signs of, §51, p10.
Signs of, §44, p7.
Pregnant cow, Care of a, §44, p7.
Premature birth, §26, p15.
Prenatal, or intra-uterine, influences, §26, p31.
Prepotency, §26, p34.
Presentation, Abnormal, §26, p13.
Normal, §26, p13.
Preservatives in milk, Use of, §45, p26.
Preserved milk, §45, p32.
Printers, Butter, §47, p29.
Production, Records of, §43, p1.
Profits in milk production, §46, p1.
of feed and care of cattle, Effect on, §46, p3.
of method of milking, Effect on, §46, p4.
Protein, §45, p6.
in feed, Functions of, §25, p9.
in feeds, §25, p5.
Ptyalin, §25, p11.
Puberty, §26, p10.
Pulp, Beet, §50, p48.
Pure-bred animal, §26, p38.
-bred cattle, Shipping of, §43, p28.
Purse, §26, p9; §48, p3.

Q

Quality, §48, p3.
Quarters for butter making, §47, p3.

R

Rack, or crate, Breeding, §50, p35.
Ram, §26, p3.
Range cattle, Texas and Western, §49, pp47, 49.
Rangers, Western, §49, p49.
Ration, Making up a balanced, §25, p31.
Quantity of, §25, p21.
Rations, Balanced, §25, p29.
for baby-beef cattle, §51, p33.
for dairy cows, §44, p3.
for dual-purpose cows, §51, p20.
for feeders, §51, p37.
Recessive character, §26, p24.
Record books, §26, p50.
for twenty cows, Seven-day milk, §46, p9.
Records, Breeding, §26, p49; §43, pp23, 24.
of milk, Keeping of, §46, p8.
Rectangular barn for 20 cows, §41, p35.
barns, §50, p6.
basement barn, §41, p68.
Red Polled cattle, §42, p32; §48, pp7, 46.
Register of merit, §42, p8.
Registering of cattle, §51, p51.
Registration of dairy cattle, §44, p22.
Registry, Advanced, §26, p55.
Application for, §44, p23.
Certificate of, §44, p24.
Regurgitation, §25, p13.
Rennet, §25, p12; §45, p6.
Rennin, §25, p13.
Repeller, §26, p14.

Reproduction, §26, pp1, 2.
Reproductive organs, Female, §26, p6.
organs, Male, §26, p9.
Reticulum, §25, p12.
Reversion, §26, p18.
Revolving churns, §47, p21.
Ribs, Fore, §48, p3.
Richness of cream for churning, §47, p50.
Rings, Bull, §50, p36.
Ripeness of cream for churning, §47, p51.
Ripening of cream, §47, p42.
of cream, Artificial, §47, pp43, 44.
of cream, Natural, §47, p43.
Rochester milk regulations, §46, p24.
Roll, §49, p7.
Roofing materials, §50, p3.
Roofs for dairy barns, §41, p13.
Rooms in dwellings as butter-making quarters, §47, p4.
Root crops, §25, p28.
Roots, §50, p49.
Ropy milk, §45, p37.
Rotater, §26, p14.
Roughage, Dry, §25, p24.
feeds, §50, p44.
Succulent, §25, p27.
Round barn for 76 cows, §41, p61.
barn for 105 cows, §41, p62.
barn of the University of Illinois, §41, p58.
barns, §50, p4.
dairy barn, §41, p57.
Rudimentary teats, §43, p14.
Rumen, §25, p12.
Rump, §43, p3; §48, p3.
Rut, §26, p10.

S

Sale of surplus stock, §43, p87.
Saliva, §25, p11.
Salt boxes, §50, p36.
Salting of butter, §47, p55.
Samplers, Cream, §47, p33.
Sanitary milk pail, Excluding bacteria by use of, §45, p18.
Score, §26, p53.
card, §26, p53.
card for beef-breeding cattle, §49, p63.
card for Berkshire swine, §26, p54.
card for dairy cow, §43, p4.
card for market beef cattle, §49, p62.
card for stockers and feeders, §49, p64.
card of the City of New York, §46, pp26–30
card, Use of, §43, p1; §49, p61.
Scoring, §26, p53.
Scrotum, §26, p9; §48, p3.
Scrub, §26, p38.
Scrubbing brushes, §47, p31.
Season at which to breed cows, §51, p9.
Secretion of milk, §45, p1.
Time of milk, §45, p3.
Selected milk, §46, p30.
Selection, Artificial, §26, p32.
Natural, §26, p32.
Selling breeding stock, Methods of, §51, p29.
Semen, §26, pp6, 9.
Separation, Centrifugal, §47, pp8, 35.
Deep-setting, §47, pp15, 38.
Devices for deep-setting, §47, p16.
Devices for gravity, §47, p15.
Devices for shallow-pan, §47, p16.
Devices for water-dilution, §47, p18.
Gravity, §47, p37.
of cream, §47, p35.
Shallow-pan, §47, pp15, 37.
Water-dilution, §47, pp15, 39.
Separator mechanism, Centrifugal-, §47, p10.
Tubular-bowl, §47, p12.
Separators, Centrifugal, §47, p8.
Cleaning of cream, §45, p22.
Complex-bowl, §47, p13.
Hollow-bowl, §47, p11.
Types of centrifugal, §47, p11.
Serving, §26, p10.
Sex, Determination of, §26, p47.
Shade, Shed for, §50, p24.
Shallow-pan separation, §47, pp15, 37.
-pan separation, Devices for, §47, p16.
Shears, Dehorning, §50, p35.
Sheath, §26, p9.
Shed and feed lots at the Illinois Experiment Station, §50, p19.
and feed lots at the Missouri Experiment Station, §50, p16.
and storage barn, Combined, §50, p15.
for shade, §50, p24.
Sheds, §50, p15.
Shipping cattle, §49, pp51, 52.
of breeding stock, §51, p32.
of pure-bred cattle, §43, p28.
Shoat, §26, p3.
Short feeding, §51, p34.
Shorthorn cattle, §42, p32; §45, p7; §48, pp5, 7, 9, 52.
Shoulder, §48, p3.
point, §48, p3.
vein, §48, p3.
Shoulders, §43, p3.
Silage, §25, p27; §50, p47.
Simmenthal cattle, §42, p29.
Single-standard breeding, §48, p16.
Sire, §26, p3.
Sites for dairy barns, §41, p6.
Size, §26, p36.
Skim-milk, §45, p1; §46, p32.
-milk, Babcock test of, §47, p41.

Skim-milk, Condensed, §46, p33.
Soiling crops, §25, p27.
Soils for dairy-barn sites, §41, p7.
South Dakota Agricultural College, Barn of the, §41, p52.
Sow, §26, p3.
Soybean hay, §50, p44.
Soybeans, §50, p43.
Spaying, §26, p47.
Spermatozoa, §26, p5.
Sport, §26, p27.
Spring houses as butter-making quarters, §47, p5.
Springers, Grades of, §49, p3.
  Milkers and, §49, pp3, 46.
Stable, Bacteria from dust of, §45, p17.
Stables, Bacteria prevalent in dark, §45, p18.
Stag, §26, p47.
Stall, Model, §41, p24; §45, p13.
  New Ideal, §41, p25; §45, p14.
  Van Norman, §41, p23.
Stallion, §26, p3.
Stalls, §41, p19.
  without ties or stanchions, §41, p26.
Stanchions, §41, p19.
  Metal, §41, p20.
  of wood and metal, §41, p22.
  Stalls without ties or, §41, p26.
  Wooden, §41, p21.
Standard of excellence, §26, p53.
  scale of points, §26, p53.
Standards for milk, §46, p17.
  of Canada, Milk, §46, p32.
  of the United States, Milk, §46, p17.
  State milk, §46, p19.
  Table of state milk and cream, §46, p18.
Starter, §47, p43.
State milk standards, §46, p19.
Steam boilers in a dairy, §46, p42.
Steer, §26, p47.
Steers, Choice, §49, pp3, 5, 10.
  Common rough, §49, pp3, 5, 12, 13, 20.
  Medium, §49, pp3, 5, 10.
  Prime, §49, pp3, 5.
Sterile, §26, p6.
Sterility, §26, p16.
Sterilized milk, §46, p32.
Still cattle, §49, p47.
Stirrers, Cream, §47, p33.
Stock, Advertising of breeding, §51, p28.
  heifers, Common, §49, pp3, 28, 40.
  heifers, Good, §49, pp3, 28, 40.
  heifers, Medium, §49, pp3, 28, 40.
  Methods of selling breeding, §51, p29.
  Sale of surplus, §43, p27.
  Selection of foundation, §51, p2.
  Shipping of breeding, §51, p32.
Stockers and feeders, §49, pp3, 27.
  and feeders, Score card for, §49, p64.
  Grades of, §49, p3.
  Management of, §51, p34.
  Yearling, §49, pp3, 28, 36.
Storage barn, Combined shed and, §50, p15.
Storing of milk, Cooling and, §45, p24.
Stover, Corn, §50, p47.
Stomach, Digestive changes in the, §25, p11.
  of a horse, §25, p14.
  of an ox, §25, p12.
Strainers, Cream, §47, p33.
Straining, §26, p13.
  of cream for churning, §47, p52.
  of milk, §45, p23.
Straws, §25, p25.
Striking back, §26, p18.
Strippings, §45, p8.
Stud, §26, p3.
  books, §26, p50.
Succulent feeds, §50, p47.
Sugar, Milk, §45, p6.
Summer feeding of beef-breeding cows, §51, p16.
Supernumerary teats, §43, p14.
Supplemental feeds, §25, p23.
Surplus stock, Sale of, §43, p27.
Sussex cattle, §48, pp5, 40.
Swine, Score card for Berkshire, §26, p54
Swinging churns, §47, p24.
Swiss cattle, Brown, §48, pp7, 28, 50.
Switch, §48, p3.
Symmetry, §26, p36.

T

Table for cattle, Gestation, §44, p11; §51, p12.
  of average composition of American feedstuffs, §25, p38.
  of comparison of the digestibility of feeds by horses and sheep, §25, p19.
  of comparison of the producing power of 3 cows for one year, §46, p3.
  of composition of milk at different stages of a single milking, §45, p8.
  of composition of milk of cows of different breeds, §45, p7.
  of composition of milk of different species of animals, §45, p5.
  of cost in four different states of producing 100 pounds of milk and 1 pound of butter fat, §46, p2.
  of state milk and cream standards, §46, p18.
  of total dry matter and total digestible nutrients in 100 pounds of American feedstuffs, §25, p52.
  of Wolff-Lehmann feeding standards, §25, p62.
Tables, Gestation, §26, p11.

Tail head, §48, p3.
Tank, Dipping, §50, p37.
Teats, §43, p3; §45, p2.
  Rudimentary, extra, or supernumerary, §43, p14.
Telegony, §26, p30.
Temperament of a dairy cow, §43, p9.
Temperature of cream for churning, §47, p49.
Tennessee Experiment Station, Bank barn of the, §41, p71.
Test, Babcock, §46, p13; §47, p40.
  for cream, Farrington's alkaline, §47, p48.
  for cream, Mann's acid, §47, p48.
  of milk, Wisconsin curd, §45, p43.
  outfits, Babcock, §47, p27.
Testicles, §26, p9; §26, p5.
Testing milk, §46, p8.
  outfit, Farrington's acid-, §47, p32.
  outfit, Mann's acid-, §47, p31.
Texas and Western range cattle, §49, pp47, 49.
Thermometers, Dairy, §47, p31.
Thigh, §43, p3; §48, p3.
Thurls, §43, p3.
Tie, §49, p7.
Ties or stanchions, Stalls without, §41, p26.
Timothy hay, §50, p45.
Tissues, Production of, §25, p8.
Tongue fat, §48, p3.
Transfer, Application for, §44, p25.
Troughs, Watering, §41, p28.
Tubes, Fallopian, §26, p8.
  Pavilion of the Fallopian, §26, p9.
Tubular-bowl separator, §47, p12.
Twist, §48, p3.

U

Udder, §43, p3; §45, p2; §48, p3.
  development of a dairy cow, §43, p10.
  Structure of a cow's, §45, p2.
Udders of cows, Bacteria in, §45, p11.
Umbilicus, §43, p15.
Utensils, Cleanliness of, §45, p19.
Uterus, §26, p8.

V

Vacuum cleaners for cows, §45, p15.
  milking machines, §46, p5.
Vagina, §26, p8.
Van Norman stall, §41, p23.
Variable types, §26, p26.
Variation, Degrees of, §26, p26.
  External causes of, §26, p28.
  Law of, §26, p25.
Variations, Abnormal, §26, p27.
  Discontinuous, §26, p27.
  Normal, §26, p26.
Veal calves, §49, pp3, 42.
  calves, Grades of, §49, p3.
Veals, Choice, §49, pp3, 42, 44.
  Common, §49, pp3, 42, 46.
  Good, §49, pp3, 42, 44.
  Medium, §49, pp3, 42, 44.
Vein, Flank, §43, p14.
  Shoulder, §48, p3.
Veins, Milk, §43, p3.
Ventilation, King system of, §41, p16.
  of dairy barns, §41, p15.
Vulva, §26, p8.

W

Walls for dairy barns, §41, p10.
Washing of butter, §47, p54.
  of churn, §47, p55.
  of milk cans, §46, p35.
Water-dilution separation, §47, pp15, 39.
  -dilution separation, Devices for, §47, p18.
  in digestion, §25, p16.
  in feeds, Functions of, §25, p8.
  in feeds, §25, p4.
  supply, Convenience of site of dairy barn to, §41, p8.
Watering troughs, §41, p28.
Wattle, Feeder's, §48, p3.
Weighing milk, §46, p8.
Wells, Milk, §43, p6.
Western range cattle, Texas and, §49, pp47, 49.
  rangers, §49, p49.
Westerns, Fed, §49, p49.
  Grass, §49, p49.
Wether, §26, p47.
Wheat, §50, p42.
Whole milk, §45, p1.
Winter, Care of breeding cows during, §51, p21.
  feeding of beef-breeding cows, §51, p18.
Wisconsin curd test of milk, §45, p43.
  dairy barn, §41, p46.
  Milk laws of the State of, §46, p21.
Withers, §43, p3; §48, p3.
Womb, §26, p8.
Workers, Butter, §47, p28.
Working of butter, §47, p57.
Wyoming-Texan cattle, §49, p49.

Y

Yeaning, §26, p12.